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ABSTRACT

This program (which consists of 12 activities) is aimed at increasing the career relevance of science education for all students in grades 4 through 9, while at the same time particularly encouraging female and minority students to consider careers in science and engineering. Major areas addressed in the activities are: (1) students' images of scientists; (2) sex role stereotyping in home and and class chores; (3) occupational patterns; (4) making predictions about future work habits; (5) detecting sex and race bias in written materials and in spoken language; (6) famous women and minority scientists; (7) exploring careers in science and engineering (filmstrip presentation); (8) selected science and engineering fields; (9) skills and interests needed for a science career (emphasizing skills that students already possess); (10) resources available for learning about science careers; (11) the employment outlook for scientists and engineers; and (12) career planning. Each activity includes background information, instructional strategies, and (when applicable) student materials. A list of major points addressed in this program is included. (JN)

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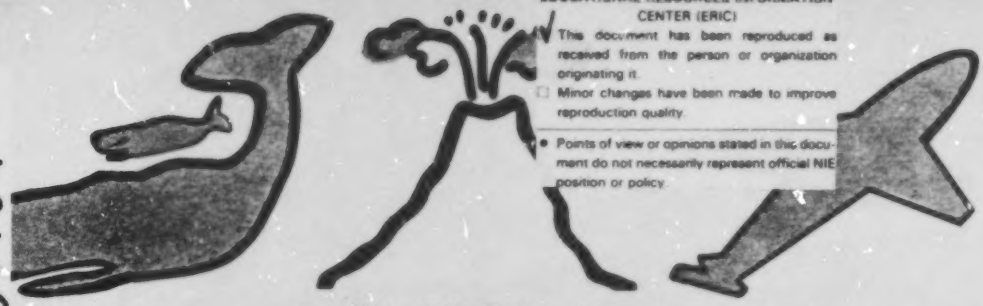

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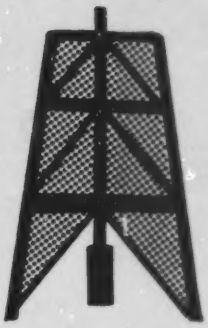

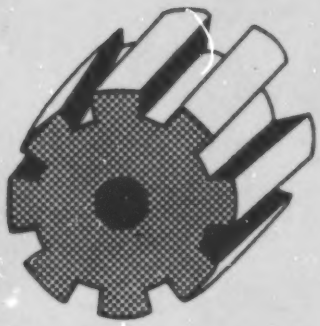

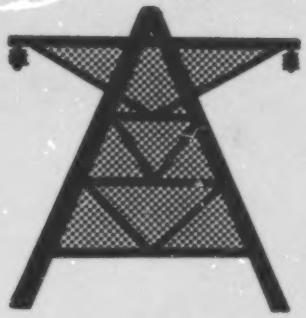

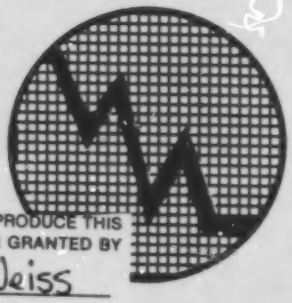

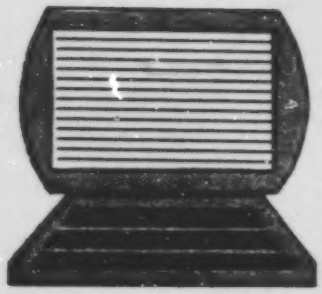

SE 045 416

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Second Edition

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Dr. Iris R. Weiss
Project Director

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INTRODUCTION

The Science Careers Program was developed by the Research Triangle Institute with the support of the National Science Foundation. The program is aimed at increasing the career relevance of science education for all students in grades 4-9, while at the same time particularly encouraging female and minority students to consider careers in science and engineering.

The major points addressed in this program are:

1) There are a diversity of science and technology careers requiring different kinds of skills and different levels of training and education.

2) One does not need to be a genius to succeed in a career in science and technology.

3) The ability to be a successful scientist is not restricted to any one race or sex.

4) Successful science careers can be combined with full personal lives; women need not give up marriage and motherhood to pursue these careers.

5) Students need not decide on a particular career at this stage but should begin thinking about various alternatives.

6) There are a variety of resources available for learning more about specific science and technology careers.

7) It is especially important for students to keep their options open by getting a good background in science and mathematics.

The Science Careers Program consists of 12 activities, each with brief background information for teachers and detailed guidelines for use of the activity. To assist teachers in preparing to use the class activities we have provided a book of "Resource Materials for Teachers." These materials are divided into the following 6 sections:

1. Objectives
2. Sex, Race and Handicap Role Stereotyping
3. Facts About Women and Minorities in the Labor Force
4. Role Models
5. Science and Engineering Careers
6. Learning More About Science and Engineering Careers

ACTIVITY 1

INVESTIGATING STUDENTS' IMAGES OF SCIENTISTS

I. Background Information for Teachers

In 1956, high school students were asked to give their impressions of scientists by agreeing or disagreeing with a series of statements about scientists. The results[1] included:

1. 35% believed it is necessary to be a genius to become a good scientist;

2. 25% thought scientists as a group are more than a little bit "odd;"

3. 27% thought that scientists are willing to sacrifice the welfare of others to further their own interests;

4. 28% believed scientists do not have time to enjoy life; and

5. 30% believed that one can't raise a normal family and become a scientist.

At about the same time, another group of high school students was asked to complete the sentence "When I think about a scientist I think of ...." The general image that emerged was:

> "The scientist is a man who wears a white coat and works in a laboratory. He is elderly or middle aged and wears glasses. He is small. He may be bald, or may be unshaven and unkempt. He may be stooped and tired.
>
> He is surrounded by equipment: test tubes, bunsen burners, flasks and bottles, a jungle gym of blown glass tubes and weird machines with dials. The sparkling white laboratory is full of sounds: the bubbling of liquids in test tubes and flasks, the squeaks and squeals of laboratory animals, the muttering voice of the scientist.
>
> He spends his days doing experiments. He pours chemicals from one test tube into another. He peers raptly through microscopes. He scans the heavens through a telescope [or a microscope!]. He experiments with plants and animals, cutting them apart, injecting serum into animals. He writes neatly in black notebooks."[2]

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[1] Purdue Opinion Panel as reported in Chemistry and Engineering News, October 29, 1956.

[2] Mead, Margaret & Métraux, Rhoda, "Image of the Scientist among High-School Students," Science (Vol. 126), p. 387, 1957.

I. Background (cont'd)

In the late 1970's researchers in England[3] asked students to complete the sentence "When I think of a scientist I think of ...." as well as the 4 other sentences listed in B below. They found that the caricature of a scientist has remained virtually unchanged for 20 years: "A mad professor wearing a white coat ... ginger hair, half-bald, talking with a German accent and peering over the top of his glasses;" "a man in a white coat with a bald head and glasses, writing on a clipboard standing in front of a bench covered with apparatus." Almost all of the students who specified the sex of their image said "he."

The image of scientists as hard-working, unattractive geniuses, almost always white males, who are basically uninterested in people and unsuccessful with them may discourage many students from considering science careers. One of the major purposes of including the posters and filmstrip presentation in the Science Careers Program is to provide tools for teachers to use to show students that this stereotype is inaccurate. Scientists vary a good deal. They may be male or female, black or white. Many do not have glasses and many rarely if ever wear a white lab coat. Some work in laboratories, others primarily at their desks or outdoors. Scientists usually work in teams. They have the same full personal lives as people in other occupations, including marriage, children, hobbies, travel, etc.

The purpose of this activity is to determine the image of scientists held by the students in your class.

II. Guidelines for Teachers

A. Have the students complete the following sentence, either in class or as a homework assignment:

When I think of a scientist I think of ....

Then ask the students to draw a picture of the scientist they described.

(If you would rather not have the students draw pictures, ask them to picture a scientist in their minds--what the scientist looks like, is wearing, is doing.)

B. Ask for volunteers to read their sentences and/or show their pictures of scientists to the class. You may wish to post several pictures together and have the students discuss the similarities (all males? wear glasses? lab coats? working with lab equipment?, etc.).

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[3]Helen Weinreich-Haste in Alison Kelly (editor), Girls and Science Education, Manchester University Press: Manchester, England, 1980.

C. Ask students to raise their hands to indicate if the scientist they described was:

Sex		Race or Ethnic Background		Work Environment	
1. Male	_____	1. White	_____	1. Laboratory	_____
2. Female	_____	2. Black	_____	2. Office	_____
		3. Hispanic	_____	3. Outdoors	_____
		4. Other	_____	4. Other	_____

and write the numbers on the board.

D. Collect the papers and look over student responses. Pick out excerpts to read to the class that describe students' images of scientists.

E. Discuss with the class their images of scientists, reading excerpts from their papers without using student names. Another way to get students to voice their stereotypes is to ask them if they think they would like to be scientists and why. You may also read excerpts from the background information and ask students how their images of scientists differ from those of students in the 1950's.

ACTIVITY 2

SEX ROLE STEREOTYPING IN HOME AND CLASS CHORES

I. Background Information for Teachers

Sex and race role stereotyping appear to be major deterrents to the participation of women and minorities in science careers. Included in such role stereotyping are the various ways in which parents, teachers, counselors, and curriculum materials give female and minority children the idea that only certain roles are appropriate for them--such as homemaker, secretary, or nurse for women and unskilled laborer for minorities.

The purpose of Activity 2 is to make students aware of sex role stereotyping on the part of parents, teachers, and educational materials. The article "Women's Lib Comes to Class" included in Section 2 of the Resource Materials for Teachers contains a "Chauvinistic Index for Educators" that will help you determine the extent to which you currently reinforce sex role stereotyping in your classroom.

II. Guidelines for Teachers

A. Have the class generate a list of approximately 10 home or class chores that young people are sometimes asked to do (e.g., make their beds, mow the lawn, set the table, move desks, water plants).

B. Write the headings "Males" and "Females" on the board. Ask the students to indicate if any of those chores seem to be performed mainly by males or mainly by females; list these under the appropriate headings.

C. Discuss the meaning of the word "stereotyped." (A stereotype is an oversimplified generalization about a group; it usually has negative connotations.)

D. Encourage the students to talk about how they may have gotten the idea that certain tasks are appropriate for only one sex. Some questions you might use to stimulate discussion are:

1. How do parents give children the idea that some tasks are "boy" tasks or "girl" tasks?

2. Would your friends call a boy a "sissy" if he helped bake cookies?

3. Do teachers usually specify they want "a strong boy" for some tasks?

4. Do only girls volunteer for "girl" tasks?

5. Do books show girls and boys doing only stereotyped things--girls sewing and boys climbing trees?

ACTIVITY 3

PEOPLE AT WORK

I. Background Information for Teachers

Activity 3 deals with occupational patterns. The major point here is that women and minority workers tend to be concentrated in low-paying, dead-end jobs. Section 3 in the RESOURCE MATERIALS FOR TEACHERS includes a list of "Facts about Women and Minorities in the Labor Force"; it provides information about both their current status and trends over the last several decades.

There is considerable evidence that the patterns of occupational segregation by sex and race originate long before entry into the labor force. By the time students are able to choose their courses of study there are sex and race differences in course enrollments. For example, a National Center for Education Statistics study of 1982 vocational education enrollments found that men still make up the bulk of enrollments in industrial arts, technical, trade, and industrial and agricultural programs but there are relatively few minority men in the agriculture and technical areas. Women still constitute more than 75 percent of the enrollment in home economics, health, and homemaking courses.

To determine how the situation in your school system compares to the picture in the nation as a whole, you could investigate questions such as the following:

1. Do males and females have equal opportunities to participate in sports?

2. What are the male and female enrollments in various home economics, industrial arts, mathematics, science, and social science courses?

3. Are minority students proportionately represented in these courses?

4. Has the situation changed very much in the last 5 years or so?

II. Guidelines for Teachers

A. Careers for Men and Women

1. Hand out the worksheet "Careers for Men and Women" and ask students to indicate if each job is done mostly by men, mostly by women, or about equally by both.

2. Put the job titles and response choices on the board. Then after students have completed the worksheet, go through the examples asking students to raise their hands to indicate their responses. You may wish to write the numbers responding "Mostly Men," "Mostly Women," and "About Equal Numbers of Men and Women" on the board or simply put a check in the column that represents the majority response.

3. OPTIONAL: Ask students to guess the percent women in a particular occupation, then give them the actual percentage.

	Occupation	Percent Women[1]
1.	Architects	13
2.	Lawyers	15
3.	Secretaries	99
4.	Engineers	6
5.	Doctors	16
6.	Registered Nurses	96
7.	Dentists	7
8.	Librarians	87
9.	Nursery School Teachers	98
10.	College Teachers	36

4. Ask students if they notice a pattern about the salaries paid by the various jobs. Point out (if no one else does) that the salaries in careers that have traditionally been for men tend to be higher than those in "women's" careers. For example, doctors earn a lot more than nurses, dentists more than dental assistants, and college teachers more than nursery school teachers.

5. Point out that in some countries women are actively involved in careers that we consider "male" careers.

   a. In several countries in Western Europe 18 to 25 percent of the doctors are women.

   b. In West Germany 33 percent of the lawyers are women.

   c. In the Soviet Union women are 28 percent of the engineers, 38 percent of the scientists, and 75 percent of the doctors.

   d. More than 10 percent of the physicists in China are women, compared to less than 5 percent in the United States.

6. Give examples to show that while there is still a long way to go, the trend in this country is for more women to enter traditionally male careers.

   a. While only 15 percent of practicing physicians in 1982 were women, women received more than 25 percent of the MD degrees awarded in that year.

   b. In 1983, women received 13 percent of the total number of bachelor degrees in engineering, compared to less than 2 percent in 1973.

[1] SOURCE: Employment and Earnings, U.S. Department of Labor, Bureau of Labor Statistics, March 1984.

Name: _____

Student Worksheet

CAREERS FOR MEN AND WOMEN

	Career		Mostly Men	Mostly Women	About Equal Numbers of Men & Women
1.	Architects	1.	_____	_____	_____
2.	Lawyers	2.	_____	_____	_____
3.	Secretaries	3.	_____	_____	_____
4.	Engineers	4.	_____	_____	_____
5.	Doctors	5.	_____	_____	_____
6.	Registered Nurses	6.	_____	_____	_____
7.	Dentists	7.	_____	_____	_____
8.	Dental Assistants	8.	_____	_____	_____
9.	Nursery School Teachers	9.	_____	_____	_____
10.	College Teachers	10.	_____	_____	_____

B. Race Role Stereotyping

1. Write the following job titles and response categories on the chalkboard (the percent of minority workers employed in each occupation is provided for your information):[2]

Percent Black	Percent Hispanic	Total % Minority		Very Few Minority Workers	A Lot of Minority Workers
.05	2	2.05	a. Airplane Pilots		
5	5	10	b. Carpenters		
38	8	42	c. Garbage Collectors		
15	12	27	d. Groundskeepers and Gardeners		
4	2	6	e. Computer Programmers		
3	2	5	f. Engineers		
22	7	29	g. Bus Drivers		
23	9	32	h. Janitors		
3	1	4	i. Lawyers		
42	12	54	j. Private Household Cleaners and Servants		

Ask the students which of the listed occupations they think have a lot of minority workers.

2. OPTIONAL: Tell the students the actual percentages of minorities in some or all of these occupations. Since blacks are about 9 percent and Hispanics 5 percent of all workers, they are clearly underrepresented in some occupations such as pilots and lawyers and overrepresented in others such as garbage collectors and private household workers.

3. Point out that, as is the case for women workers, minority workers tend to be concentrated in low-paying jobs. Relatively few minority workers are employed in professional and technical jobs.

[2] SOURCE: Employment and Earnings, U.S. Department of Labor, Bureau of Labor Statistics, March 1984.

ACTIVITY 4

PREDICTIONS FOR YOUR FUTURE

I. Background Information for Teachers

Activity 4 involves students in making predictions about their future, and makes the point that most women will work outside their homes, many out of pressing economic necessity. The "Facts About Women and Minority Workers" included in Section 3 of the RESOURCE MATERIALS FOR TEACHERS will be a useful resource for this activity.

II. Guidelines for Teachers

A. Have the students complete the worksheet "Predictions for Your Future."

B. PART A: Ask first the girls and then the boys to raise their hands if they said yes to question 1a; record these numbers on the board. Then do the same for question 2.

	Number YES	
	Females	Males
1a. Expect to work outside the home?	_____	_____
2. Expect to get married?	_____	_____

C. Ask for volunteers to read their guesses for Part B. For each question, write a number on the board which seems to represent the class consensus. Then read the actual statistics and have the students record them on their papers.

___ 1. In 1984 approximately 4 out of every 10 workers were female, and 6 out of 10 were male.

___ 2. Nine out of 10 women will work outside their homes at some time in their lives.

___ 3. Women will work for an average of about 29 years.

___ 4. In 1984, 61 out of every 100 women with children under 18 were working.

D. Have the students prepare a bar graph with the results. On one bar graph have the students graph:

1. The number of girls in the class who expect to work outside the home.

2. According to present projections, the number of girls in the class who will in fact have jobs. (Use the following to find the number of girls in the class responding to 9 out of 10.)

Total Number of Girls in Class	10	11	12	13	14	15	16	18	19	20
90% (Number for bar graph)	9	10	11	12	13	14	15	16	17	18

E. Discuss the differences between the class responses and the actual statistics on working women:

1. How does the number of girls who expect to work compare to the number who will probably work?

2. How realistic are the students' expectations for how long they will work?

F. Point out that many women work because they <u>have</u> to:

1. Many women have to support themselves because they are single or because they become widowed or divorced.

2. Many families depend on both the husband and wife working in order to make ends meet.

G. Collect the papers and look at the students' current occupational plans.

Name: _____

PREDICTIONS FOR YOUR FUTURE

A. Personal Predictions

1a. Do you think you will work outside the home as an adult? Yes ___ No ___

b. If yes, what job or occupation do you expect to have?

_____

2. Do you think you will get married at some time in the future? Yes ___ No ___

B. Guessing the Facts

Record your "guesses" for the following questions.

	GUESS
1. Out of every 10 workers in the United States, how many are female?	____
2. Out of every 10 girls in the U.S., how many do you think will have jobs at some time in the future?	____
3. The typical man works outside the home for 38 years. How many years will the typical woman work outside the home?	____
4. Out of every 100 women with children under 18, how many do you think have jobs?	____

ACTIVITY 5

DETECTING SEX AND RACE BIAS IN LANGUAGE

I. Background Information for Teachers

In Activity 2 students learned how parents and teachers sometimes restrict children to stereotyped roles. Textbooks and other educational materials can also reinforce sex and race role stereotyping. The purpose of this activity is to help students recognize sex and race bias in written materials as well as in spoken language.

Section 2 of the RESOURCE MATERIALS FOR TEACHERS includes a number of materials that will be useful here. "Racism in the English Language" provides an excellent summary of the pervasiveness of racism in both spoken and written language. The pamphlet entitled "10 Quick Ways to Analyze Children's Books for Racism and Sexism," and the checklist "How to Tell if a Textbook is Biased" will help teachers to determine if their instructional materials need supplementation. Teachers can also use these considerations in evaluating new textbooks, films, filmstrips, and other instructional materials for possible purchase.

II. Guidelines for Teachers

A. Remind the students that in an earlier activity they learned how parents and teachers may restrict children to stereotyped roles. Point out that textbooks can also show sex and race bias in this way. Give them examples such as the following drawn from studies of textbooks in use in the 1970's. Then mention that textbook publishers are now making greater efforts to eliminate sex and race bias and more recent books are less biased than earlier ones.

1. Elementary readers had many more stories about boys than about girls. Boys were shown as active and full of energy; girls were usually shown watching and waiting.

2. Adult women were usually shown as housewives, ignoring the fact that so many adult women worked outside their homes. Those who were shown working were almost always in stereotyped roles such as teacher, nurse, librarian, or sales clerk. Adult males, on the other hand, were shown in a wide variety of occupations, including very prestigious ones.

3. Textbooks had more than twice as many pictures of boys than girls. Relatively few illustrations showed minority people.

4. Science and social studies textbooks rarely mentioned the accomplishments of women and minorities in these fields.

5. Word problems in arithmetic texts had boys building things, earning money, going places; girls were usually shown cooking or sewing, or purchasing materials with which to cook or sew.

B. Point out that the language we use, both spoken and written, may be biased against women and/or minorities. Hand out the first page of the worksheet "Detecting Sex and Race Bias in Language" and ask the students to complete Part I by indicating if each statement shows sex bias, race bias, or neither. Go over the statements one at a time, asking for volunteers to tell if the example shows sex bias, race bias, or neither; explain why; and tell how the example can be changed to eliminate any bias.

PART I.

1. Jim was always the black sheep in our family.

   Race Bias - "Black" is used in a negative way. An alternative statement could be: Jim was the member of our family who was always getting into trouble.

2. Let's ask the man in the street for his opinion.

   Sex Bias - "Man" and "his" exclude women. Stated another way: Let's ask some people in the street for their opinions.

3. The teacher asked for a strong student to move the desks.

   Okay As Is - There is no suggestion here that only boys can be strong.

4. The Europeans defended themselves against attack by the savage Indians around them.

   Race Bias - This statement implies that the lands rightfully belonged to the Europeans. An alternate statement could read: The Native Americans tried to defend their homelands against the Europeans who wanted their lands.

5. The weaker sex.

   Sex Bias - Women are not necessarily weaker than men. Similarly, terms like "the fair sex" or referring to adult females as "the girls" are sexist.

6. The firefighters rushed out in answer to the alarm.

   Okay As Is - Sex-neutral terms should be used whenever possible--firefighter for fireman, performer for showman, repairer for repairman, salesperson for salesman, ancestor for forefather supervisor for foreman, mail carrier for mailman, etc.

7. David's careless act will stand as a black mark against him in the future.

   Race Bias - "David's careless act will be held against him in the future." Language that uses the word "black" in a negative way should be avoided--e.g., black sheep, blackmail, blacklist, blackballed. Such expressions give children the mistaken impression that being black is inferior to being white.

PART I. (continued)

8. The pioneers moved West, taking their wives with them.

   Sex Bias - "The pioneer families moved West." Women should not be considered possessions. Similarly, "man and wife" is sexist. Use instead either husband and wife or man and woman.

9. Mary Johnson is a very successful woman doctor.

   Sex Bias - "Mary Johnson is a very successful doctor." One would not say that James Johnson is a successful man doctor.

10. The President spoke to the well-dressed black officials.

    Race Bias - "The President spoke to the black officials." It can be assumed that any officials, black or white, would be well-dressed, especially when being addressed by the President.

C. OPTIONAL: Hand out Part II of the worksheet and have students look for examples of sex and race bias, either in class or as a homework assignment.

PART II.

1. Sex Bias - This is an excerpt from an elementary science textbook published in 1970. The use of "men" and "he" excludes women.
2. Sex Bias - Elementary readers frequently have stories such as this where mother is confused or helpless and father is powerful or all-knowing.
3. Sex Bias - This group of arithmetic problems is typical of many found in elementary mathematics books. And, as a group, they reinforce sex stereotypes. In these examples the males are shown doing exciting things (flying an airplane, investing a large sum of money, building a tree house) while the females are shown in the more mundane and stereotypically female activities of buying groceries and fabric and setting the table. The last problem is also typical--females are shown as finding mathematics difficult, often needing to seek out help from males.
4. Race Bias - This statement equates misbehaving with acting like Indians.
5. Race Bias - "Blacken" is used as the opposite of good. The teacher could have said "I hate to ruin your good record...."
6. Sex Bias - This statement assumes that the postal employees are men.

PART II. (continued)

7. Sex Bias - First, the term "Brotherly Love" excludes women. Second, Martha's appearance is considered noteworthy while Michael's intelligence is the important point.

8. Race Bias - Referring to Africa as a "dark continent" gives an image of deep, mysterious jungles inhabited by primitive savages.

D. OPTIONAL: Have students write to textbook publishers for copies of these guidelines. Among the publishers who have produced such guidelines are:

1. Holt, Rinehart and Winston Publishing Company
   383 Madison Avenue
   New York, New York 10017

2. MacMillan Publishing Company, Inc.
   866 Third Avenue
   New York, New York 10022

3. McGraw Hill Book Company
   1221 Avenue of the Americas
   New York, New York 10020

4. Scott, Foresman and Company
   1900 East Lake Avenue
   Glenview, Illinois 60025

Name _____

DETECTING SEX AND RACE BIAS IN LANGUAGE

Tell whether each of the following statements shows sex bias, race bias, or no bias.

PART I.

	Sex Bias	Race Bias	No Bias
1. Jim was always the black sheep in our family.	_____	_____	_____
2. Let's ask the "man in the street" for his opinion.	_____	_____	_____
3. The teacher asked for a strong student to move the desks.	_____	_____	_____
4. The Europeans defended themselves against attack by the savage Indians around them.	_____	_____	_____
5. The weaker sex.	_____	_____	_____
6. The firefighters rushed out in answer to the alarm.	_____	_____	_____
7. David's careless act will stand as a black mark against him in the future.	_____	_____	_____
8. The pioneers moved West, taking their wives with them.	_____	_____	_____
9. Mary Johnson is a very successful woman doctor.	_____	_____	_____
10. The President spoke to the well-dressed black officials.	_____	_____	_____

Name_____

DETECTING SEX AND RACE BIAS IN LANGUAGE

PART II.

Indicate how each of the following shows sex or race bias.

1. "Man is a curious animal. He wants to know all about nature. Ever since the earliest days, he has looked toward the heavens with wonder."

2. "Mother said I can't get Mike. I will get Daddy. Daddy can go up the tree. He will get Mike down."

3. a. If a man flies his airplane 250 miles...
   b. If a woman walks two blocks to the grocery store...
   c. If Mr. Jones invests $10,000 in stocks...
   d. If Mrs. Jones buys three yards of cloth at $5.00 a yard...
   e. Sam needs an additional 12 feet of lumber for the tree house he is building...
   f. Susan needs two forks for each place she is setting at the table...
   g. Jane was having trouble balancing her checkbook...

4. The teachers decided to hold indoor olympics on rainy days so that students could use their energy to have fun rather than behaving like a bunch of wild Indians.

5. It surprised everyone when Paul, a school leader, was found throwing rocks and breaking out windows at school. His teacher told Paul, "I hate to blacken your good record, but I will have to report you to the principal."

6. Tom Brooks was helping out at his father's bakery one Saturday. Mr. Brooks asked Tom to take some special cakes to the post office to mail to customers in other towns. As he handed Tom the cakes, he said, "You remind those fellows at the post office to be careful with my cakes."

7. Martha Hilliard likes living in Philadelphia, a city some people call "The City of Brotherly Love." Martha moved to Philadelphia to teach at Temple University. Students say she is one of the most attractive professors at Temple. Her husband Michael is a brilliant statistician.

8. Alex gave a report in class on his family background. Some of his ancestors came to the United States as slaves. "My family story begins several hundred years ago on the dark continent of Africa," Alex told the class.

ACTIVITY 6

FAMOUS WOMEN AND MINORITY SCIENTISTS

I. Background Information for Teachers

Many of your students have probably heard of George Washington Carver and Marie Curie but few are aware of the very significant contributions women and minority scientists have made despite the obstacles they faced. This activity focuses on a number of women and minority scientists who managed to overcome great barriers and serve as pioneers in their fields.

Section 4 of the RESOURCE MATERIALS FOR TEACHERS includes a compendium of famous women and minority scientists and engineers as well as references for obtaining additional information. There is also a list of the famous women and minority scientists keyed to topics in science curricula.

II. Guidelines for Teachers

A. Have each student construct a chart for recording information about famous women and minority scientists using some or all of the following headings:

	Scientist Name	Science Field	Major Contribution	Barriers Encountered	Other
1.					
2.					
3.					

B. Distribute or read information sheets 1 and 2 (selected black and women scientists and engineers) to the class, having the students fill in their charts as they go along.

C. Have the students use their charts to help them complete the puzzles.

1. The "Scrambled Scientists" worksheet can be completed either in class (singly or in small groups) or as a homework assignment.

2. Have the students complete the "Famous Women and Minority Scientists Crossword Puzzle." You may wish to post the solution so students can check their answers.

3. OPTIONAL: Have the students search for the "Hidden Scientists." You may wish to set this up as a contest to see who can find the most names. Or you may assign some students to look for minority scientists and others for women scientists.

D. OPTIONAL: Read or distribute information sheets 3 and 4 (additional black and women scientists and engineers) and have the students fill in their charts for these scientists.

E. OPTIONAL: Lead a discussion about the barriers to participation in science careers. Some topics you might discuss are:

1. The importance of role models - What effect does it have on young girls never to see women in cetain careers? on minority students never to see people of their own race in certain careers?

2. Early role stereotyping - Are boys asked about their plans for careers more often than girls are? When people ask boys what they want to be, what careers do they suggest? what about girls? Who gets the doctor's kit? the nurse's kit?

3. Poverty - Many bright students are unable to continue their education because their families cannot afford to send them to college. This is particularly true of minority students, since a larger proportion of them are from low-income families.

4. Discrimination - While discrimination on the basis of race or sex is illegal it still occurs, and in the past it was routine--women and blacks barred from certain schools, jobs, etc.

5. Difficulties in combining career and family - There's no question that having both a career and a family is a lot of work. Arrangements that are helping men and women combine the two include one or both spouses working part-time; both sharing childcare and housekeeping responsibilities; using part of the income from the two jobs to hire outside childcare and/or housekeeping help; and taking a break in the career when children are young.

F. OPTIONAL: Assign individual students to find out more about particular famous women and minority scientists and report to the class.

INFORMATION SHEET #1

Black Scientists and Engineers

Black scientists and engineers have made many important contributions to their fields. The best known American black scientist is GEORGE WASHINGTON CARVER who had a major impact on agriculture in the South. Cotton crops were being destroyed by the boll weevil beetle. Dr. Carver conducted many experiments and showed that other plants including peanuts, sweet potatoes, and soybeans should be planted along with cotton. He also developed hundreds of useful products from these plants, including bleach, dyes, instant coffee, linoleum, meat tenderizer, shampoo, and talcum powder.

The earliest famous black scientist is BENJAMIN BANNEKER. Born to free blacks in Maryland in 1731, Banneker was a self-taught mathematician and astronomer. He used mathematical calculations to predict the eclipse of the sun in 1789. In 1792 he developed his first almanac based on his study of the stars. Banneker's almanacs, published each year until 1806, soon became as popular as Benjamin Franklin's Poor Richard's Almanac had been. Banneker is often used as an example of the kinds of accomplishments blacks could have had were it not for slavery.

In early 1940 when Europe was involved in World War II, soldiers needed blood desperately but there was no way to preserve blood longer than a few days. DR. CHARLES DREW, an American black medical scientist, developed a method for storing blood plasma without spoiling. After the war, Dr. Drew was appointed the first director of the American Red Cross Blood Bank. At one point he was told not to allow blood from black volunteers to be mixed with the blood of whites. Dr. Drew opposed this racial segregation of blood and was asked to resign his position.

Chemist DR. PERCY JULIAN developed a method for the inexpensive production of a remedy for arthritis using parts of the soybean plant. As a result of Dr. Julian's work, the arthritis medicine was available to many people who previously could not have afforded it. Percy Julian became rich and famous as a result of his work, but he still suffered from the effects of racial discrimination. On one occasion he was invited to attend a scientific meeting and then asked not to come because blacks were not welcome at the meeting place. When he bought a home in an all-white suburb of Chicago, vandals tried to burn the house down to prevent his family from moving in and terrorists later exploded a bomb in the house (which fortunately did not injure anyone).

There have been a number of well known black engineers and inventors, including ELIJAH McCOY who is most famous for the development of a device to oil machines automatically. New machines were examined to see if they contained "the real McCoy," a phrase which ir now used to mean genuine quality. The son of former American slaves who escaped to Canada in search of freedom, Elijah McCoy received more than 50 patents for his inventions, and started his own company to manufacture them. Unfortunately some people became less enthusiastic about using his devices when they learned the inventor was a black man.

LEWIS LATIMER, an electrical engineer, was also the son of a runaway slave. He became an electrical engineer and was the only black member of Thomas Edison's research team. Latimer was the one who invented the carbon filament (the fine wire which lights up) that was used in Edison's light bulbs.

GARRETT MORGAN invented an automatic stop sign, the forerunner of modern traffic lights. He also developed a safety helmet and gas mask for firemen and became something of a hero when he used his invention to rescue people trapped by an explosion in a tunnel being built under Lake Erie.

Electrical engineer GRANVILLE WOODS received patents for more than 35 electrical inventions including a third rail system for an electrical locomotive, an improved airbrake system, and a telegraph system for letting train engineers determine how close their trains were to other trains. Granville Woods later sold many of his inventions to major companies, including General Electric, Westinghouse, and Bell Telephone.

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INFORMATION SHEET #2

Women Scientists and Engineers

Compared to the large numbers of male scientists over the centuries, there have been very few women in science careers. However, in spite of the difficulties they faced in becoming scientists, many women have made important contributions to these fields.

The earliest woman mathematician was HYPATIA. She had the advantage of growing up in Ancient Greece at a time when women were not excluded from intellectual pursuits. Hypatia wrote several textbooks and was the inventor of the astrolabe and the planisphere, two instruments used to study the stars. Being female was not Hypatia's problem; she was dragged from her chariot and killed because of her political and religious beliefs.

Over the years there have been many women inventors, but often men were given credit for their wive's inventions, as was the case with SIBELLA MASTERS, whose invention for cleaning and airing corn was patented in her husband's name. Among other inventions by women are a folding cabinet bed, a paper bag machine, a snow plow, railroad cars, and fire escapes.

Many other women have made significant contributions in biology, the physical sciences, mathematics, and engineering. Astronomer ANNIE JUMP CANNON identified and classified over 200,000 stars, more than anyone else in the world. She received the first gold medal ever given to a woman by the American National Academy of Sciences.

BEST COPY AVAILABLE

Ecologist RACHEL CARSON was one of the first people to warn about the dangers of technological progress to our environment. As an employee of the United States Fish and Wildlife Service, Ms. Carson became aware of the dangers of pesticides such as DDT. Her book Silent Spring caused many people to become concerned about abusing our planet and helped lead to legislation controlling the use of pesticides.

Mathematician GRACE HOPPER was one of the first people to ever work with computers. She devised a "compiling system" which acts as a translator between human beings and computers. She also helped develop a computer language that is widely used in business.

Marine biologist DIXIE LEE RAY was the first women appointed to head the U.S. Atomic Energy Commission. She was later elected governor of Washington state where she was able to apply her scientific knowledge to helping preserve the environment.

In science, the award of a Nobel prize represents the ultimate achievement, and a number of women scientists have received this recognition. MARIE CURIE shared the 1903 Nobel prize in physics with her husband Pierre and A. H. Becquerel for their studies of radiation. In 1911 she won a second Nobel prize, this time in chemistry, for her discovery of the chemical elements radium and polonium. While she was the first person ever to receive two Nobel prizes, she was discriminated against because she was a woman, and was turned down for a vacancy at the French Academy. In 1932 she died of leukemia, a disease brought on by her extensive contact with radioactive materials.

Marie Curie's daughter, IRENE JOLIET-CURIE, carried on the work her parents had begun, and in 1935 she shared the Nobel prize in chemistry with her husband Frederic for their work in producing new radioactive elements.

Between 1947 and 1977, four other women scientists were awarded Nobel prizes--two. They are:

1. Gerti Cori - 1947 Nobel prize in prize in physiology
2. Maria Goeppert Mayer - 1963 Nobel prize in physics
3. Dorothy Crowfoot Hodgkin - Nobel prize in chemistry
4. Rosalyn Yalow - 1977 Nobel prize in phsysiology

INFORMATION SHEET #3

Additional Black Scientists and Engineers

Engineer, NORBERT RILLIEUX received a patent for a process that greatly reduced the cost and danger of producing sugar. He started his work in his native Louisiana, but faced so much racial discrimination that in 1854 he moved to France to continue working on his inventions.

DR. DANIEL HALE WILLIAMS is credited with performing the first "open-heart" surgery in 1893 when he saved the life of a knifing victim by sewing up his heart.

CHARLES HENRY TURNER was an expert on the behavior of ants and bees. He developed a way of observing insects and recording the way they reacted to each other and to outside influences. He discovered that bees are attracted to flowers by color and by smell as well as by their patterns. One type of insect behavior Dr. Turner described in detail was named after him; it is called "Turner's circling."

ERNEST JUST was a research biologist who studied the structure and function of animal cells. He wrote many scientific papers and two books, including one which was used in many college courses. In 1915 Dr. Just was awarded the Spingarn Medal by the NAACP in recognition of the work he had done to advance the progress of blacks. Dr Just was a well known expert on cells and was invited to work in some of the finest research laboratories in Europe. However, he faced discrimination in this country, and was not invited to work in most of the top American laboratories.

LLOYD HALL, a chemist, applied his knowledge of chemistry to problems in the food industry. He was responsible for the development of seasonings, meat curing products, and other products used in preserving foods. He received patents for over 100 items and served as consultant to a number of United States agencies, including the Food and Drug Administration.

INFORMATION SHEET #4

Additional Women Scientists

ALICE HAMILTON was the first American physician to study hazardous working conditions of mills and factories. Her work in detecting poisonous substances in the air and dust of manufacturing plants led to safety laws and compensation for employees who suffered work related illnesses.

During World War II FLORENCE VAN STRATEN joined the Navy as a Wave and was trained in meteorology. Her job was to find ways to use knowledge of weather conditions in planning military strategy. One of her major accomplishments was to improve techniques for using weather balloons.

CHIEN SHIUNG WU came to the United States from China in 1936 to study nuclear physics at Berkeley. Her work was of such high quality that she was asked to teach at Princeton University and later at Columbia University. Her research corrected previous ideas about the physical structure of the universe.

Biochemist GERTI CORI shared the 1947 Nobel prize in physiology and medicine with her husband Carl for their work in carbohydrate metabolism. Dr. Cori's early education had been in acquiring the cultural graces considered essential for women of her social class. When she decided she wanted to become a doctor she had to spend several years studying the math, science, and other subjects she had not learned in school before she could begin medical school.

Physicist MARIA GOEPPERT MAYER was the first woman to receive the Nobel prize in theoretical physics (in 1963). Interestingly, she spent most of her professional life as an unpaid researcher since the universities that employed her husband had nepotism laws that prevented her from being hired.

DOROTHY CROWFOOT HODGKIN used X-rays to study the structure of complex molecules. Her accomplishment included analyzing the structure of penicillin, enabling the production of large quantities of the antibiotic during World War II, and discovering the structure of Vitamin B-12, for which she won the 1964 Nobel prize in chemistry.

One problem in medical research is the difficulty of accurately measuring chemicals that occur in small amounts in the body. ROSALYN YALOW helped develop a new technique for measuring tiny amounts of chemicals in the body and was awarded the 1977 Nobel prize in physiology for her work.

Other women scientists have contributed greatly to the work that led to Nobel prize awards for others, including ROSALIND FRANKLIN whose work with X-rays was an essential part of the research that later resulted in Watson and Crick's discovery of the structure of DNA.

1. "SCRAMBLED SCIENTISTS"

The names of some famous scientists are listed below in scrambled form. Using the clues to help you, unscramble the name of each scientist.

	CLUE	
1.	The first woman mathematician	PATHYIA _ _ _ _ _ _ _ _
2.	Published an almanac based on his study of the stars	JENNBAMI KENNERAB _
3.	Only Black person on Thomas Edison's research team	WILES MARITEL _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _
4.	Studied the effects of DDT	CHAREL SONARC _ _ _ _ _ _ _ _ _ _ _ _ _ _
5.	Electrical engineer credited with many inventions	LARGELVIN OSWOD _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _
6.	Developed hundreds of useful products from plants such as peanuts, sweet potatoes and soybeans	EROEGG SHAGTINOWN RACREV _
7.	Won Nobel prize for discovery of radium	EMIRA RUICE _ _ _ _ _ _ _ _ _ _ _ _ _ _
8.	Developed a method for storing blood	RASHECL WEDR _ _ _ _ _ _ _ _ _ _ _ _ _ _ _
9.	Developed a widely used computer language	CAREG PEROPH _ _ _ _ _ _ _ _ _ _ _ _ _ _
10.	Identified more than 200,000 stars	NINEA PUMJ NANCON _

2. FAMOUS WOMEN AND MINORITY SCIENTISTS CROSSWORD PUZZLE

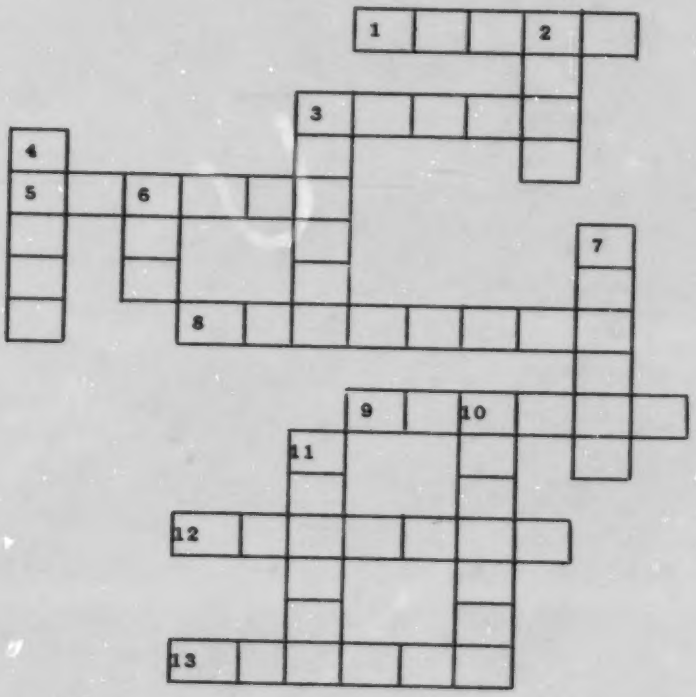
Clues

DOWN

2. His work led to the formation of blood banks
3. Identified more stars than any other person
4. "The real _____ "
6. Biologist who became governor of Washington
7. Invented an automatic stop sign
10. Member of Edison's research team
11. One of the first people to work with computers

ACROSS

1. Held patents for more than 35 electrical inventions
3. She and her daughter both won Nobel prizes
5. Author of The Silent Spring
8. Self-taught black mathematician and astronomer
9. Developed inexpensive remedy for arthritis
12. Famous Greek mathematician
13. Famous black agricultural scientist



3. "HIDDEN SCIENTISTS"

This puzzle contains the last names of many famous women and minority scientists, engineers, and inventors. The names are written up and down, across, and diagonally. Some are written backwards. Circle the name of each famous scientist you find.

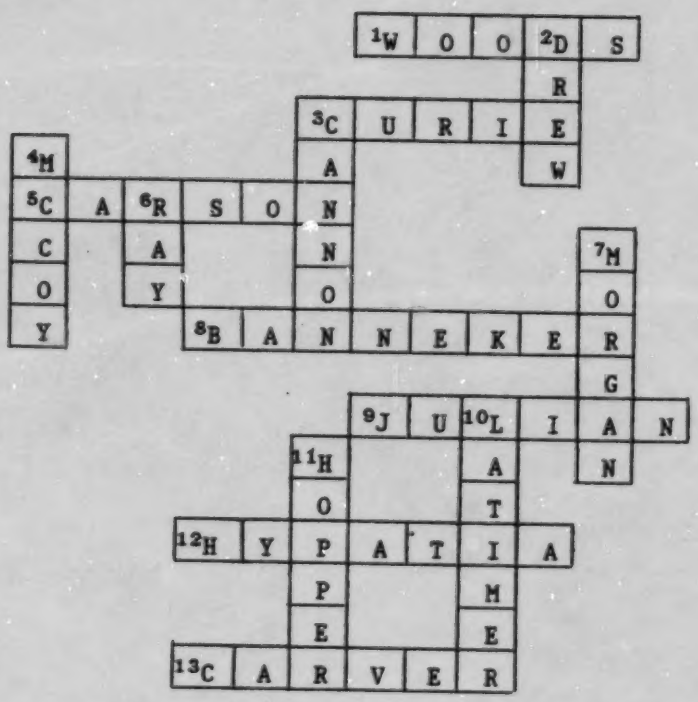
M O R G A N U J D M A S T
O O N D Y O N O S R A C O
R W E O O S D L R A E O D
R U C A N R E I C D R W S
E C A B A N N E K E R A R
M E R H M A A T C U R I E
I I V O C I T C H Y P T T
T L E P C L I U D R W A S
A O R P O U M R A Y E P A
L J C U R J E I C A R Y M
K E N N A B R E P P O H Y

Answers

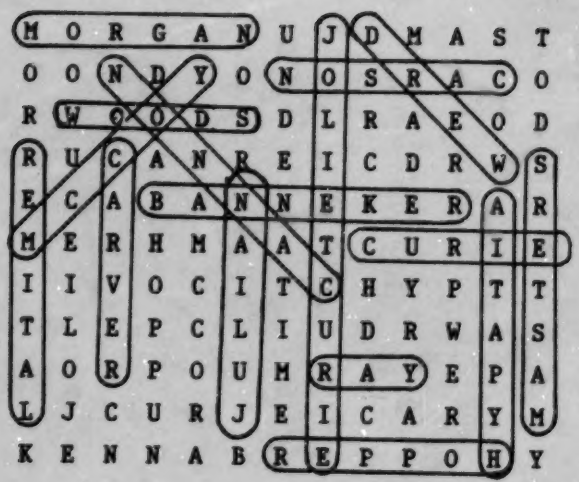
C.1 "SCRAMBLED SCIENTISTS"

1. Hypatia
2. Benjamin Banneker
3. Lewis Latimer
4. Rachel Carson
5. Granville Woods
6. George Washington Carver
7. Marie Curie
8. Charles Drew
9. Grace Hopper
10. Annie Jump Cannon

C.2 CROSSWORD PUZZLE



C.3 "HIDDEN SCIENTISTS"


M O R G A N U J D M A S T
O O N D Y O N O S R A C O
R W O O D S D L R A E O D
R U C A N R E I C D R W S
E C A B A N N E K E R A R
M E R H M A A T C U R I E
I I V O C I T C H Y P T T
T L E P C L I U D R W A S
A O R P O U M R A Y E P A
L J C U R J E I C A R Y M
K E N N A B R E P P O H Y

ACTIVITY 7

FILMSTRIP PRESENTATION: EXPLORING CAREERS IN SCIENCE AND ENGINEERING

I. Background Information for Teachers

The purpose of this filmstrip is to show students that there are a diversity of science and engineering careers available and that a variety of different types of people are pursuing these careers. Specifically, the filmstrip attempts to:

1. make students aware of the nature of the work done in a number of science and engineering fields;

2. illustrate that the traditional stereotyped image of science and scientists does not reflect the diversity of modern science careers; and

3. show students that science careers are appropriate pursuits for women, minority, and handicapped persons.

4. make students aware of the importance of adequate high school preparation in mathematics and science for future careers.

Section 5 of the RESOURCE MATERIALS FOR TEACHERS contains some factual information about science and engineering careers, including participation of women and minorities, numbers of persons employed in each field, employment outlooks, and salary information. A list of definitions of science and engineering fields is also included. An article on combatting handicap stereotyping is included in Section 2. You should also have the set of scientist posters handy so you can refer to them in the class discussion following the filmstrip presentation.

II. Guidelines for Teachers

A. Show the science and engineering sound filmstrip presentation. Please note that the soundtrack has been recorded identically on both sides of the cassette tape included in this package. One side of the cassette is equipped with AUDIBLE tones for use on manual equipment. (Advance the filmstrip one frame each time you hear the "beep".) The reverse side is equipped with INAUDIBLE 1,000 H_z pulses to change frames automatically. A copy of the script with storyboard images has also been provided. The tape begins with the frame immediately following the "FOCUS" frame. Teachers who wish to use the side with INAUDIBLE pulses on manual (non-automatic) projectors may do so by following the script and storyboard and advancing one frame at a time after each section of text.

B. Ask students to think back to their earlier responses to "When I think of a scientist I think of..." and tell how their image of scientists has changed.

C. Ask students the following questions.

1. What types of companies employ scientists and engineers?

   The slide presentation included companies involved in producing chemicals, automobiles, food and drugs. Students should be able to think of other examples, including companies in the local area. Mention that at the present time there are many more job opportunities for scientists and engineers in industry than in universities, and that the demand for computer scientists and engineers is particularly great.

2. The filmstrip mentioned that it is very important to take math and science courses, even if you find them difficult. Do you think you have to be a genius to become a scientist?

   The idea that you must be brilliant to enter a science field is a myth. One of the scientists included in this program indicated that she had to struggle with her college coursework. She didn't give up, however, and earned the chemistry degree that has allowed her to have a successful career at Colgate Palmolive. Many, many other people had difficulty with their high school or college coursework but kept at it so they could achieve their goals.

3. The filmstrip showed James Albert, a computer scientist who is confined to a wheelchair after a motorcycle accident. He was able to continue his career as well as his race-car driving. Do you think it's possible for people with other types of handicaps to work as scientists and engineers? Are there any things they could not do?

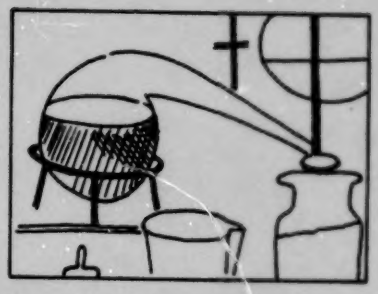
   John Gavin, director of allergy research at Miles Laboratory in Indiana, has his secretary listen in on his phone calls and repeat the caller's words so that he can lip-read and then reply. Often the caller is not even aware that John is deaf. Many other handicapped persons have successful science careers.

   While some handicapping conditions may limit career choices to some degree, there are so many different types of science and engineering career opportunities that people interested in science can usually find careers that match their skills and interests. A blind person would probably not work in a job that involved pouring chemicals, but could do lots of other kinds of research.

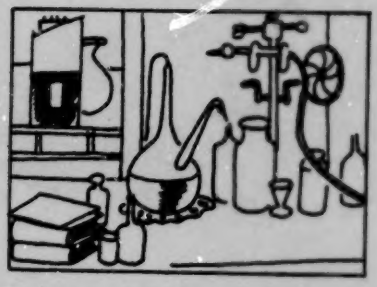
4. It's hard to imagine the weird scientist in the laboratory we saw at the beginning of the filmstrip out jogging or playing with his kids. But we've seen that most scientists are not very much like that "mad scientist." Do you think it is possible to combine a career in science or engineering with a full personal life?

Scientists and engineers are a very diverse group of people with a lot of different life styles. Some of the scientists in the posters are single, others are married but have no children, and still others have children. They have a wide variety of leisure activities, including gardening, cooking, painting, photography, music, dance, fishing, jogging, tennis, golf, handball, football, softball, basketball, white-water canoeing, and race car driving.

Filmstrip Presentation:
EXPLORING CAREERS IN SCIENCE AND ENGINEERING



1. Gurgle sounds. (5 seconds)



2. Gurgling of chemicals, eerie music. (4 seconds)

3. <u>Boy with a big imagination:</u> "You know what a scientist is...he's one of those old men wearing white coats...

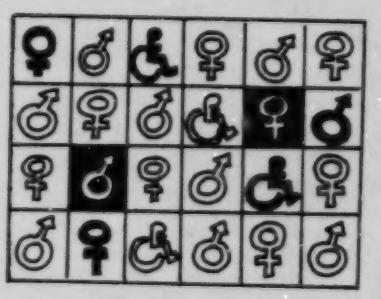
4. ...who do strange experiments in laboratories...

5. ...mixing mysterious chemicals and..."

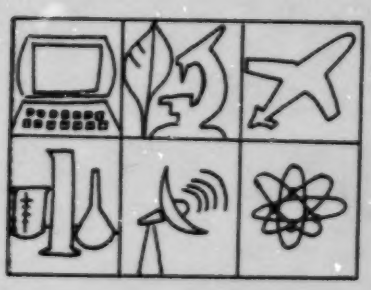
6. Girl student: "Oh, knock it off, that's crazy! My sister is a scientist. She does wear a white coat but..."

7. Student: "...and my uncle is a scientist who uses computers to design airplanes."

8. Student: "And my mother is a geologist with the oil company. She works outdoors a lot and wears blue jeans to work."

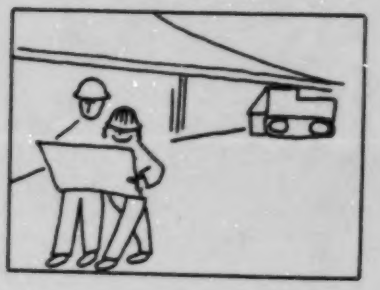


9. Narrator: All kinds of people have jobs in Science and Engineering.



10. Scientists and engineers work in a variety of settings and do many different types of work.

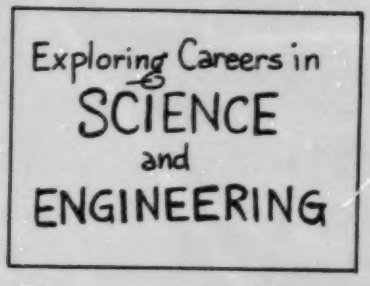
11. They conduct geological surveys to help locate oil & other valuable minerals.



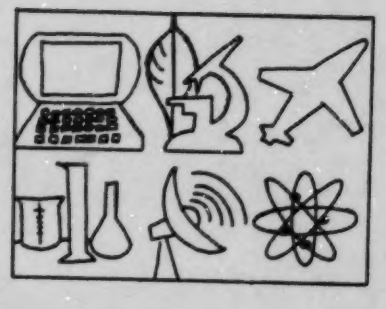
12. They work on transportation systems, designing and supervising the construction of bridges and highways.

13. They design industrial equipment, computers, and aircraft...

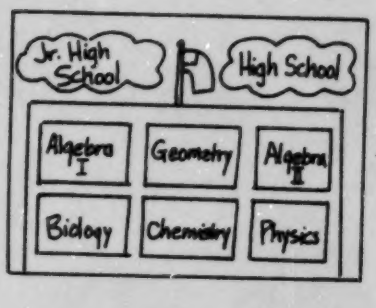
14. ...as well as doing laboratory research in health, agriculture and the environment.



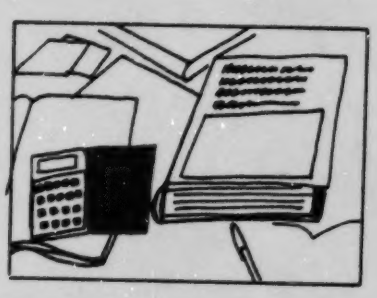
15. A career in science or engineering might be for you. Let's take a few minutes to explore the idea.



16. Although scientists and engineers do very different kinds of jobs, they all have one thing in common.

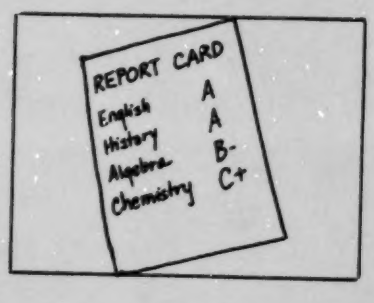


17. They studied Math and Science in school.

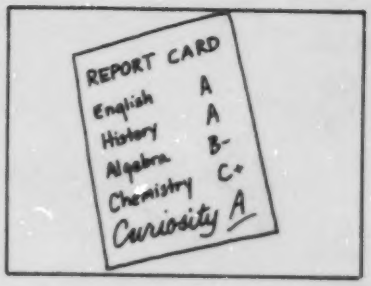


18. ...and they use what they learned in those courses to solve challenging problems...

19. ...and make technological advances that help all of us.

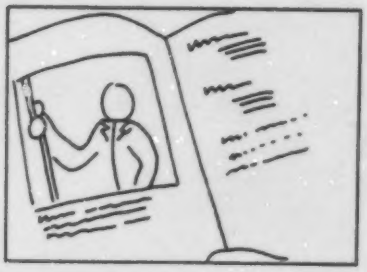


20. Student: "Sometimes my math and science courses are difficult for me. But I've always been interested in how things work and I'm good at finding cut why things happen. Can I really consider a career in science?"



21. Narrator: Curiosity is just as important as good grades and can lead to a science career as well.

22. Narrator: There is a great demand for people with science and engineering training. The salaries are high. Doesn't it make sense to get in on the more challenging, better-paying jobs?

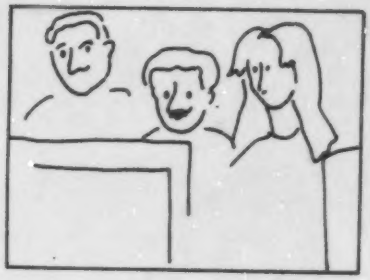


23. Student: "Do minorities and women really get jobs as scientists? In my textbooks there are hardly any women or black scientists."

24. Narrator: You're right. In the past only a few minorities and women studied to become scientists.

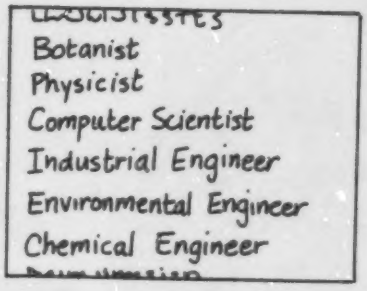
25. That's no longer true. Now minorities and women are employed as entomologists and botanists...

26. They're employed as physicists...

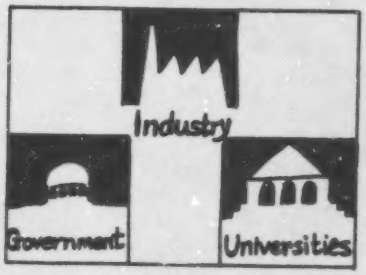


27. ...as computer scientists and industrial engineers.

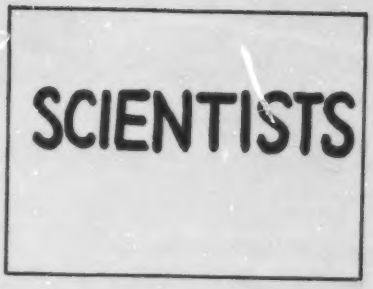
28. ...as chemists...and biologists...



29. Student: "Botanist, physicist, computer scientist, industrial engineer, environmental engineer...I didn't realize there were so many different careers in science."



30. Industry, the government, and universities have many different jobs for people with training in science and engineering.



31. Scientists are curious people. They are always asking questions and want to find answers to problems.

32. They want to find how to cure diseases.

33. They are interested in the world's energy resources.

34. They want to know,"what is happening to our natural environment?"

35. This botanist specializes in the study of plant diseases.

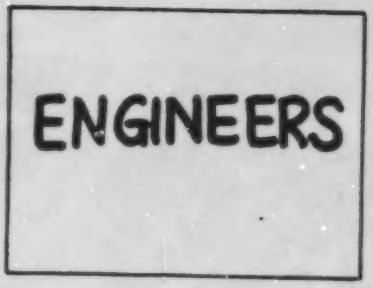
36. At Brown University a graduate student in geology takes samples from a lake for a study of what causes changes in the climate.

37. These two computer scientists are working on programming a robot system.

38. James Albert uses computers to design airplanes and train pilots. He is confined to a wheelchair but this handicap does not stand in the way of his career as a scientist.

39. At Delmonte Corp., Wayman Wong is developing a new food product.

40. Shirley Mason is a chemist who works for the Sun Petroleum Company.



41. There are more engineers than any other type of scientist. Engineers apply science and math knowledge to solve practical problems.

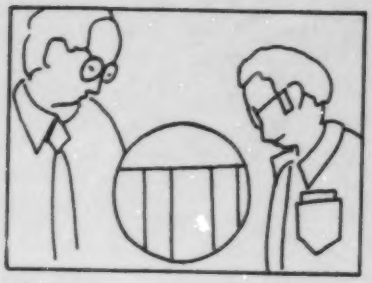
42. They want to learn how to build pollution-free engines.

43. ...how to advance space travel.

44. How to create plastics, synthetic fabrics and other new materials.

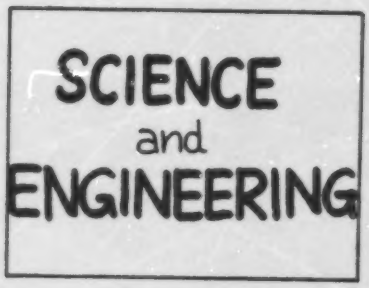
45. Sharon Okonski, an electrical engineer, is working on a system for automatic collection of data during space flights. She works for the government.

46. Most engineers work in private industry. This research engineer at Dupont, is working on a new process for burning organic wastes.



47. At General Motors, Wayne Lo directs a team of engineers working on automobile pollution.

48. Gary Daugherty works at Owens-Corning Fiberglas Corp. He is designing ventilation systems.



49. Student: "Wow! There sure are lots of careers in science and engineering." Narrator: "So what's a scientist?"

50. Students: "A man...

51. ...a woman!...

52. ...who wears a white coat...

53. ...blue jeans and a hard hat...

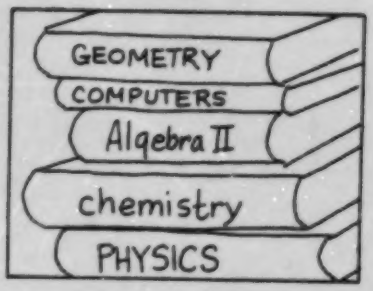
54. ...space suit...

55. ...and works in a lab...

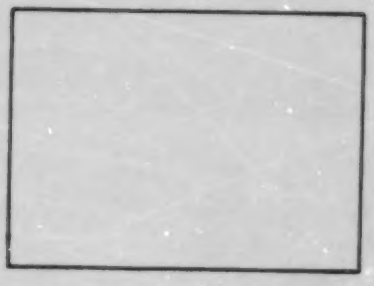
56. ...on a platform drilling rig...

57. ...at a desk...

58. ...outdoors...



59. So.....stay with your math and science courses. If you do, many careers will be open to you when you finish school.



60. Credits (5 seconds)

61. Credits (5 seconds)

62. Credits (5 seconds)

63. Credits (5 seconds)

ACTIVITY 8

BRANCHES OF SCIENCE AND ENGINEERING

I. Background Information for Teachers

This activity expands upon the filmstrip presentation by having the students learn about specific science and engineering fields. The "Definitions of Selected Science and Engineering Fields" included in Section 5 of the RESOURCE MATERIALS FOR TEACHERS would be a valuable aid to have available as your class works on this activity.

II. Guidelines for Teachers

Make a transparency of page 8.6 and display it, covering up all but the top three boxes with a piece of paper.

A. Ask the students if they know the basic distinction between scientists and engineers.

> Scientists generally work on discovering new knowledge. Engineers then apply knowledge to solve practical problems. Engineers begin with a "how to" problem--how to build a bridge, how to turn sunlight into electricity, how to increase the output of a factory. Like scientists, they do research to find a solution and to make sure that their solution is practical. For example a civil engineer who designs a new highway which is technically sound but costs more than the government can afford has not solved the problem.
>
> The distinction between scientists and engineers is not always clear-cut and they often do very similar work. In fact many of the people employed in engineering jobs were actually trained as physicists, chemists, computer scientists, or other types of scientists.

B. Now uncover the engineering fields on the transparency. Point out that there are many more engineers than any other type of scientist, in fact more than 1 million engineers in the United States alone. Most of these are working in electrical, mechanical, industrial, and civil engineering--the four branches shown on the transparency. Read each of the following definitions to the class and ask them to name the branch of engineering being described.

(Civil) These engineers design and supervise the construction of buildings, bridges, dams, water treatment plants, and many other structures.

(Electrical) These engineers design, develop, test and supervise the manufacture of electrical and electronic equipment including radar, computers, televisions, and stereos.

(Industrial) These engineers determine the most effective ways to use people, machines, and materials in manufacturing.

(Mechanical) These engineers are concerned with the production and use of power. They design and develop machines such as automobile engines, air conditioners, refrigerators, printing presses, and elevators.

C. Point out that while the transparency shows the four major branches of engineering there are actually more than 25 different branches of engineering. Write Aerospace Engineer, Biomedical Engineer, Chemical Engineer, and Petroleum Engineer on the board. Ask students if they know what type of engineers:

1. Explore for oil and gas (Petroleum Engineers)
2. Develop new plastics (Chemical Engineers)
3. Design pacemakers (Biomedical Engineers)
4. Design missiles (Aerospace Engineers)

D. Now uncover the science fields on the transparency, mentioning that there are many different science fields included in each of these categories.

E. Have students complete the "Worksheet on Science and Engineering Careers;" then go over the questions asking for volunteers to read their answers.

F. OPTIONAL: Show the "Science-Related Fields" transparency again. Ask the class to list some scientists who fit in each of the three science categories. If the students have trouble listing scientists you could refer back to the matching activity. For example, you could say: "An astronomer studies the stars. In which of the 3 science branches would an astronomer belong?" The attached copy of the transparency lists a number of examples in each science category.

G. OPTIONAL: Select some or all of the following statements and ask students to (1) tell whether each is true or false and (2) change the underlined portion of each false statement to make it true. This can be done as a class activity, or individual students can be asked to find out the answers and report to the class. Additional background information about each field is provided for your use.

1. A person who studies the life cycle of insects might be an ornithologist. (FALSE - Entomologists study insects; ornithologists study birds. Both entomologists and ornithologists are zoologists, that is, they study animals.)

2. A person who studies enzymes found in animals might be a biochemist. (TRUE - Biochemists study the compounds found in living things. Biochemistry is an example of an interdisciplinary science, that is, one which combines two fields, in this case biology and chemistry. Other examples are biophysics and geophysics.)

3. A person who develops plans for processing large amounts of data might be a systems analyst. (TRUE - As is the case with computer programmers, most computer systems analysts work on the business applications of computers.)

4. A person who studies rock formations might be an industrial engineer. (FALSE - Industrial engineers determine the most effective ways for an organization to use people, machines, and materials in their production processes. A number of different types of scientists might study rock formations, including geologists, civil engineers, mining engineers, metallurgical engineers, petroleum engineers, and oceanographers.)

5. A person who designs power-producing machines such as car and jet engines might be a physicist. (FALSE - Physicists develop mathematical models of physical phenomena such as gravity. It is mechanical engineers who design and develop power-producing machines as well as power-using machines such as refrigeration and air conditioning equipment, elevators, etc.)

6. A person who analyzes data collected by Census takers might be a statistician. (TRUE - Statisticians design surveys and experiments and analyze and use numerical data. They also use statistical techniques to predict population growth or economic conditions, and to help managers evaluate the results of new programs.)

7. A person who investigates how the human body reacts to space travel might be a physiologist. (TRUE - This is just one of many examples of scientists who have been involved in the space program. Others include astronomers, chemists, physicists, computer programmers, aeronautical engineers, mechanical engineers, and electrical engineers.)

WORKSHEET ON SCIENCE AND ENGINEERING CAREERS

A. Unscramble the following engineering fields. Examples of the products or systems that the engineers work on are provided to help you.

_____	1. ILVIC	Buildings, dams, roads
_____	2. CIMLEACH	Rubber and plastics
_____	3. CAREAPOSE	Airplanes and rockets
_____	4. CHAINECALM	Air conditioning systems
_____	5. CALLICREET	Radios, TV sets, computers

B. Examples of Science Careers

Below you will find an example of the many different tasks in a particular science or engineering job. Match the example with a job title chosen from the list.

___ 1. Studies the growth of plants

___ 2. Designs bridges

___ 3. Studies weather patterns and tries to predict the weather

___ 4. Studies the behavior of animals

___ 5. Supervises manufacture of communications equipment such as telephones

___ 6. Develops new compounds such as perfumes

___ 7. Designs artificial hearts

___ 8. Gives detailed instructions for a machine to follow in solving a problem

___ 9. Uses a telescope to study the stars

___10. Supervises drilling for oil

Job Titles

A. Astronomer
B. Biomedical Engineer
C. Botanist
D. Chemist
E. Civil Engineer
F. Computer Programmer
G. Electrical Engineer
H. Meteorologist
I. Petroleum Engineer
J. Zoologist

PART A: Answers are (1) Civil, (2) Chemical, (3) Aerospace, (4) Mechanical, and (5) Electrical.

PART B: For each part of the matching exercise, ask students if they can name other tasks done by that type of scientist. Encourage them to give examples of scientists they know and/or companies in the area which employ those types of scientists. You may wish to use some of the following examples in the discussion.

C 1. Botanists may also work on identifying and classifying plants, or studying causes and cures of plant diseases.

E 2. Civil Engineers also design and supervise the construction of roads, harbors, airports, tunnels, buildings, and water supply and sewage systems.

H 3. Meteorologists also analyze data on wind, rainfall, sunshine, and temperature for use in designing buildings, planning heating and cooling systems, etc.

J 4. Zoologists study various aspects of animal life, they may conduct experiments with live animals in laboratories or natural settings or they may dissect animals to study their structure.

G 5. Electrical Engineers design, develop, test, and supervise the manufacture of electrical and electronic equipment including lighting and wiring in buildings, cars and aircrafts, as well as radar, computers, stereos, and televisions.

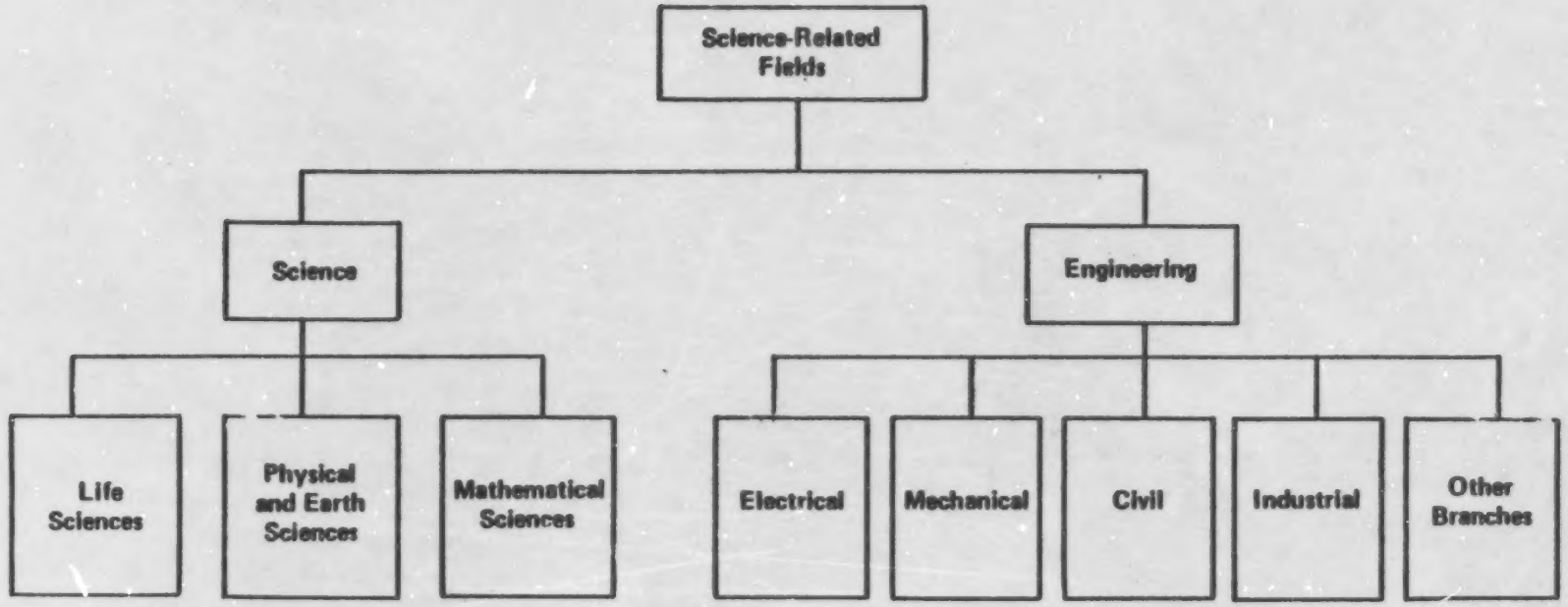
D 6. Chemists search for and apply new knowledge about substances; develop new compounds, such as rocket fuel; improve foods; create that are chemically treated against flammability, soil, and wrinkles. Most chemists work in private industry, many of them in large industrial areas.

B 7. Biomedical Engineers use engineering principles to solve health-related problems. They develop artificial hearts and kidneys, lasers for surgery, and pacemakers to regulate the heartbeat.

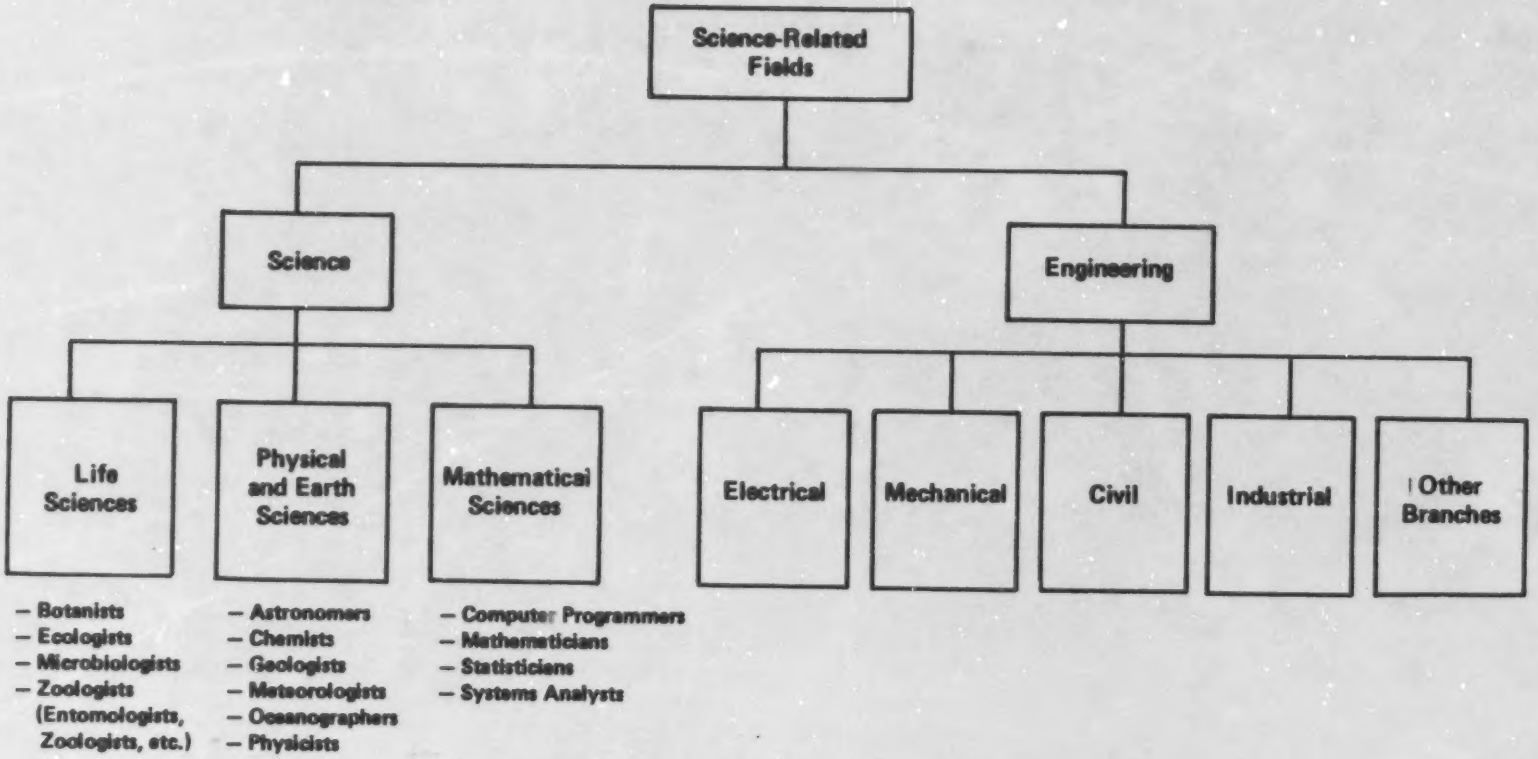
F 8. Computer Programmers are in great demand since the use of computers has expanded tremendously in recent years. Businesses which use computers need programmers to write instructions for the machine use in billing, keeping track of inventory, mailing lists, etc.

A 9. Astronomers seek answers to questions about the fundamental nature of the universe, including its origin and history; they also study the behavior of matter and energy in distant galaxies.

I 10. Petroleum Engineers are involved in exploring and producing oil and gas. They develop methods for recovering the most oil and gas possible from a given source which is very important in these times of energy shortages and rising costs.


Science-Related Fields
Science
Engineering
Life Sciences
Physical and Earth Sciences
Mathematical Sciences
Electrical
Mechanical
Civil
Industrial
Other Branches

8.6


Science-Related Fields
Science
Engineering
Life Sciences
Physical and Earth Sciences
Mathematical Sciences
Electrical
Mechanical
Civil
Industrial
Other Branches
– Botanists
– Ecologists
– Microbiologists
– Zoologists (Entomologists, Zoologists, etc.)
– Astronomers
– Chemists
– Geologists
– Meteorologists
– Oceanographers
– Physicists
– Computer Programmers
– Mathematicians
– Statisticians
– Systems Analysts

8.7

ACTIVITY 9

SKILLS AND INTERESTS NEEDED
FOR A SCIENCE CAREER

I. Background Information for Teachers

A major purpose of this activity is to show students that many of them already have skills and interests that are appropriate for science and engineering careers. A point to be stressed is that while it is certainly not necessary to be a genius, it is important to get a good background in science and especially in mathematics. An article about the importance of adequate mathematics preparation is included in Section 5 of the RESOURCE MATERIALS FOR TEACHERS.

II. Guidelines for Teachers

A. Student Science Interest Inventory

1. Have the students complete the "Student Science Interest Inventory." (These items were adapted from items used in the National Assessment of Educational Progress). Be sure to tell them that it is not a test and that there are no right answers.

2. OPTIONAL: Ask students to think of other science-related materials they would like to use. You will then be able to plan experiments using materials in the inventory or other suggested materials, especially those that female or minority students indicate they would like to use. It would be particularly effective if you work with female and minority students to plan activities they can demonstrate to the class, especially those using magnets, batteries, and bulbs.

3. The National Assessment of Educational Progress found large sex differences in responses to certain types of items, most notably those involving electricity. To see if this holds true for your class, ask first the girls and then the boys to raise their hands if they answered yes to item 7. You can read aloud additional electricity-related items and again ask for a show of hands. For example,

    a. Have you ever made a magnet using electricity and wire?
    b. Have you ever tried to fix something electrical?

    If in fact there are substantial sex differences in the responses to these items, ask the students to tell how they think these differences may have come about. Were their fathers usually the only ones who ever worked with electricity at home? Were the boys but not the girls asked to help in these projects?

On the other hand, NAEP found that girls were more likely than boys to have collected leaves or flowers or insects. Ask the students to raise their hands if they answered yes to item 8 to see if this holds true for your class.

4. Ask each student to count up the total number of "yes" responses and write that number at the top of the page where it says "#Y;" then collect the papers and keep them for future reference. Point out that those who had a large number of yes responses might want to consider a career in one of the many science-related fields.

5. Write the names of the female and minority students who appear to be interested in science as evidenced by this inventory (either because they had high scores or because they said yes to question 19).

_____ _____
_____ _____
_____ _____
_____ _____
_____ _____

Make a special effort to provide additional information on science careers to these students.

B. "Are You Suited For a Career in Science and Engineering?"

Ask students to name some skills and interests that might indicate that a person is well suited for a science career. A number of characteristics they might mention (or you can suggest) as well as points to discuss about each are provided below. You may wish to display the posters of some of the scientists mentioned in these examples.

1. CURIOSITY

Curiosity is probably the most important characteristic of scientists and engineers. They need to look at things in a questioning way. How do things work? If you do this, what will happen? Scientists want to understand the unknown. Often they want to make discoveries to help society.

Elma Gonzalez, one of the scientists in this program, was fascinated by living things even as a child, and she wound up becoming a biologist. James Albert was interested in airplanes and decided to get a degree in aerospace engineering.

Y _____

Name _____

STUDENT SCIENCE INTEREST INVENTORY

(Check one on each line.)

	YES	NO
A. Would you like to visit		
1. a planetarium?	1. _____	_____
2. a scientific laboratory?	2. _____	_____
3. a weather station?	3. _____	_____
4. a plant that generates electricity?	4. _____	_____
B. Have you ever		
5. worked with or experimented with seeds?	5. _____	_____
6. found a fossil?	6. _____	_____
7. wired together an electrical circuit?	7. _____	_____
8. collected leaves or flowers or insects?	8. _____	_____
C. Would you like to work with or experiment with		
9. living plants?	9. _____	_____
10. living animals?	10. _____	_____
11. mirrors?	11. _____	_____
12. magnets?	12. _____	_____
13. dissolving things in water?	13. _____	_____
14. floating and sinking objects?	14. _____	_____
D. Would you like to		
15. look at the moon through a telescope?	15. _____	_____
16. take something apart to see how it works?	16. _____	_____
17. visit a scientist or engineer at work? If yes, tell which types.	17. _____	_____
E. Do you		
18. often watch science shows on TV?	18. _____	_____
19. want to know more about jobs in a science or engineering field?	19. _____	_____
20. ever work with science-related hobbies? If yes, tell which ones.	20. _____	_____

_____

_____

_____

2. ENJOY SOLVING PROBLEMS

Scientists and engineers constantly face problems for which they are trying to find solutions. Scientists are trying to go beyond current knowledge to help explain something unknown. Engineers are trying to find out how to do something that has not been done or how to do something better and cheaper.

Most scientists and engineers enjoy new challenges and the process of trying to solve problems. Besides curiosity and creativity, this often involves logical thinking and the patience to accept failure and keep trying new solutions. And it can be very satisfying when they do solve a problem. Several of the scientists interviewed in preparing the posters mentioned this fact. For example, Grace Chow visits the waste water treatment plants she designs as well as the areas where the recycled water is being used because she likes to see the results of her work.

3. CREATIVE AND INVENTIVE

Engineers and scientists draw heavily upon the work of others, and they do much of their work in an orderly, logical way. However, many discoveries or inventions come about through creativity, or an imaginative way of setting up an experiment or using scientific knowledge in a practical way. If you are one of those people with a good imagination you may want to consider applying your skills to solving technical problems.

4. COMMUNICATE WELL WITH OTHERS

There are times when scientists and engineers work alone; however, most of them must rely upon others in many cases. Scientists often share current research findings with others who are working to solve similar problems. They must be able to communicate their research attempts, whether failures or successes, so that others can build upon their work.

Engineers almost always work as a part of a team. They might share ideas about how to attempt to solve a problem. Or they might use each other's strengths, with one creating a design, another building a model, and still another testing the results. Solving complex problems such as those involved in space shots, producing sufficient energy, combatting pollution, etc., almost always involve groups of different types of scientists and engineers. It used to be thought that scientists and engineers were people who liked to work with "things" rather than other people. This is certainly not true today, where working as a team is very common.

5. ENJOY LEARNING SCIENCE AND MATHEMATICS

If you enjoy learning science and mathematics now there is a good chance you would enjoy using this knowledge in the future. Teresa Trussell liked studying math and physics and chose a career that combined both--civil engineering. Jackie Jackson enjoyed learning mathematics and wound up as a computer scientist.

Some people think you need to be a genius to become a scientist or an engineer. This simply is not true. Sticking to your goals is much more important than being exceptionally brilliant. Carol Gosling-Winder and Jack Sherrill both indicated they found college coursework difficult, yet both persisted and went on to successful science careers. The same is true of many other scientists.

6. MECHANICALLY INCLINED

Some people find their way into science or engineering because of a fascination with machines which started when they were young. For example, Leo Williams had a boyhood interest in tearing apart and fixing radios and phonographs and pursued this interest into a career in electrical engineering. Traditionally it has usually been boys rather than girls who have been interested in machines. This is probably because boys were the ones who were given construction sets as toys and encouraged to help Dad in his workshop. If you are "no good with mechanical things" it may be because you never had the opportunity to try. If you do enjoy working with machines you may be particularly interested in a career as a mechanical engineer. For most other science and engineering careers it is not important that you be good at manipulating machines as long as you understand the mathematics and science principles involved in using them.

C. The Importance of Taking Mathematics

Teachers should stress that the single most important thing a student can do to prepare for a science or engineering career is to take as much mathematics in high school as possible. A set of two transparencies has been provided to help you get this point across.

First display the transparency "Math Courses Increase Job Choices!" and make the point that if you take 3 or more years of high school math you will be keeping your options open to become anything you want to be.

Make transparencies of pages 9.7 and 9.8 to help you get this point across (use different colors for the 2 transparencies if possible).

Stress the point that even if a student has no idea what he or she would like to do in the future it makes good sense to keep one's options open by taking at least 3 years of math in high school. (Three years of math usually means a year of introductory algebra, a year of geometry, and a year of Algebra II.) You may wish to distribute copies of the article "The Math in High School You'll Need for College" included in Section 5 of the RESOURCE MATERIALS FOR TEACHERS to some or all of the class.

Point out that taking these courses is important, even if they find math difficult. You may want to read the following paragraph to them; it was excerpted from a publication prepared by the University of California, San Diego.

> "Many students avoid mathematics courses and specifically avoid algebra because they are considered to be "hard" subjects. Instead, they take other subjects in which they believe a "good" grade can be more easily obtained. This is generally a serious mistake. The first, if not the sole, consideration should not be grades but gaining important and useful information and knowledge. A student who takes algebra and geometry in high school and earns a "C" grade is far better educated and has a better future with many more career options than a student who avoids these subjects and earns "A" grades in easier mathematics courses."[1]

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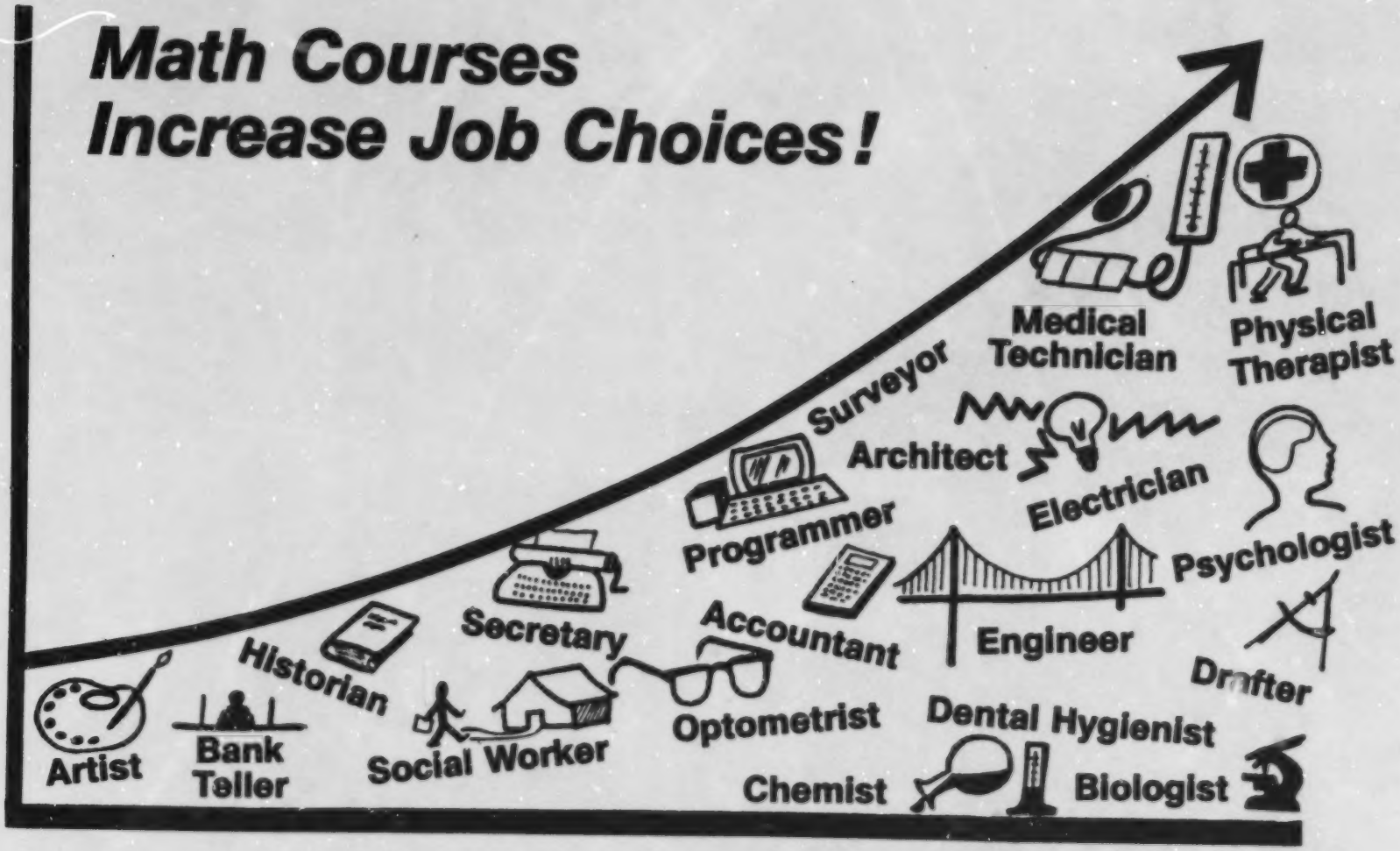
[1] "PARENTS: Protect Your Children's Future. Have Them Take Algebra and Geometry in High School," University of California, San Diego.



3 or More years of High School Math

Only 1 or 2 years

ACTIVITY 10

LEARNING MORE ABOUT SCIENCE AND ENGINEERING CAREERS

I. Background Information for Teachers

A major purpose of this activity is to acquaint students with the many types of resources available for learning about science careers. Written materials include Department of Labor publications (most notably Exploring Careers which is specifically designed for students in the middle grades and the more comprehensive Occupational Outlook Handbook); materials published by professional societies; industry brochures; as well as books, magazines, and newspapers. Section 6 of the RESOURCE MATERIALS FOR TEACHERS includes information about the Occupational Outlook Handbook and Exploring Careers and a detailed annotated bibliography of science career publications. It would be a good idea for teachers to check with the school librarian prior to introducing this lesson to determine what science career materials are available for student use.

Interacting with practicing scientists is an extremely good way for your students to learn about science careers, and Section 6 of the RESOURCE MATERIALS FOR TEACHERS contains suggestions for arranging to have scientists visit your class and to have students visit the scientists at work. Sample letters to prospective visitors as well as guidelines for the scientists to use in preparing their presentations are included.

II. Guidelines for Teachers

A. Resources for Learning About Science and Engineering Careers

1. Describe the types of resources available to students and how they can be accessed. Resources might include:

    a. Exploring Careers
    b. Occupational Outlook Handbook
    c. Professional societies (often referenced in the Handbook)
    d. Companies that employ scientists
    e. Other books in the school library, including books about famous scientists
    f. Newspapers and magazines
    g. Posters of scientists
    h. Interviews with scientists

2. OPTIONAL: Have students write for copies of some of the publications listed in the annotated bibliography included in Section 6 of the RESOURCE MATERIALS FOR TEACHERS.

3. Use the attached profile of Gloria Blue (excerpted from Exploring Careers) to give students an example of the life of a "typical" scientist. You may want to distribute copies of the profile for students to read and/or to read it to the class. Ask the students for any reactions they might have. Among the points you might discuss are:

   a. Gloria exhibits many of the skills and interests discussed in the previous activity. The students should be able to give examples--e.g., liked learning math, switched to engineering because she liked to solve problems, has creative ideas such as the idea for an equalizer, communicates well with others.

   b. Gloria started out thinking about traditionally female careers, e.g., nurse, teacher. Women interested in math and science no longer need to limit themselves to "women's careers." In Gloria's case "it took all summer to sell her parents on the idea" of her becoming an electrical engineer. This should become less difficult in the future as more and more women enter these fields and people realize these careers are appropriate for women as well as for men.

   c. Like many scientists and engineers, Gloria Blue works as part of a team. While some of her work is done at her desk she spends much of her time communicating with other people, including other engineers, her sales staff, and clients.

   d. Many scientists and engineers move into positions in management where they have the opportunity to supervise other people, handle a lot of responsibility, and generally have larger incomes.

4. Generate a list of science and engineering fields of interest to your class by asking students what types of scientists and engineers they would like to know more about.

   You may wish to refer to their responses to question 17 on the STUDENT SCIENCE INTEREST INVENTORY (which types of scientists or engineers would they like to visit at work). The attached list of science and engineering occupations may also be useful here.

   Then ask students to suggest the questions they would like to ask these people if they had the opportunity to do so. Some general possibilities include:

   a. What do you do in your job?
   b. What do you like best about your job? least?

c. How did you prepare for your career?
d. How does your job fit with your other interests--hobbies, sports, family life, etc.?

Students may also have questions they would like to ask about specific fields.

5. Arrange to have a number of scientists visit your class, including female and minority scientists. If possible, also arrange to have a small group of students visit a scientist at work. Be sure to include female and minority students in this group.

B. Student Reports on Science and Engineering Occupations

1. Have each student or group of students take the responsibility of finding out about a particular science or engineering occupation and reporting the findings to the class. You may also wish to have students turn in written reports of their research. Occupations can be assigned by the teacher or chosen by the students from a list, such as the attached list of selected science and engineering occupations or the list generated as part of number 4, activity 10A.

2. Tell the students to use the available resources, including books, pamphlets, and scientists themselves, to learn about the occupation. As they are doing their research they should try to answer questions such as the following:

a. Where are these scientists generally employed ... in industry? colleges and universities? government?

b. Where are they employed locally?

c. What kinds of things do they do on the job?

d. What educational background is required?

e. What kinds of skills and interests would be useful in this line of work?

f. What are the salaries like? the employment outlook?

g. Are there any jobs for interested teenage students to do after school or in the summer?

h. Have there been any famous women or minority scientists in this field?

3. Discuss with the students the format of the presentations to be given to the class. You may either assign particular types of presentations or allow students to choose their own. Each presentation might be some combination of the following:

   a. role-playing a scientist, including answering "interview" questions from other students;

   b. giving clues about the occupation to the class one at a time; the winner of this "What's my science field?" game is the first student who guesses the field;

   c. giving an oral report about the science occupation;

   d. giving a demonstration of an activity related to the occupation;

   e. developing and displaying a collage or other pictorial representation of the occupation;

   f. developing a scrapbook with newspaper and magazine clippings about that occupation;

   g. writing and displaying a profile of an interviewed scientist or a famous scientist, and

   h. arranging for a scientist/engineer to visit the class.

4. Supplement the student reports by displaying the posters of scientists as appropriate. For example, if several students are reporting on different types of engineers you might display a set of posters of engineers. Similarly, if students are reporting about scientists involved in solving pollution problems you might display the posters of types of scientists who work on these problems.

C. OPTIONAL: Scientists Working to Solve Societal Problems.

1. You may have one or more small groups work on this assignment. The task of each group is to (1) come up with as many different types of scientists as possible who might be included in a team working on a particular problem area and (2) describe what each would do to help solve the problems.

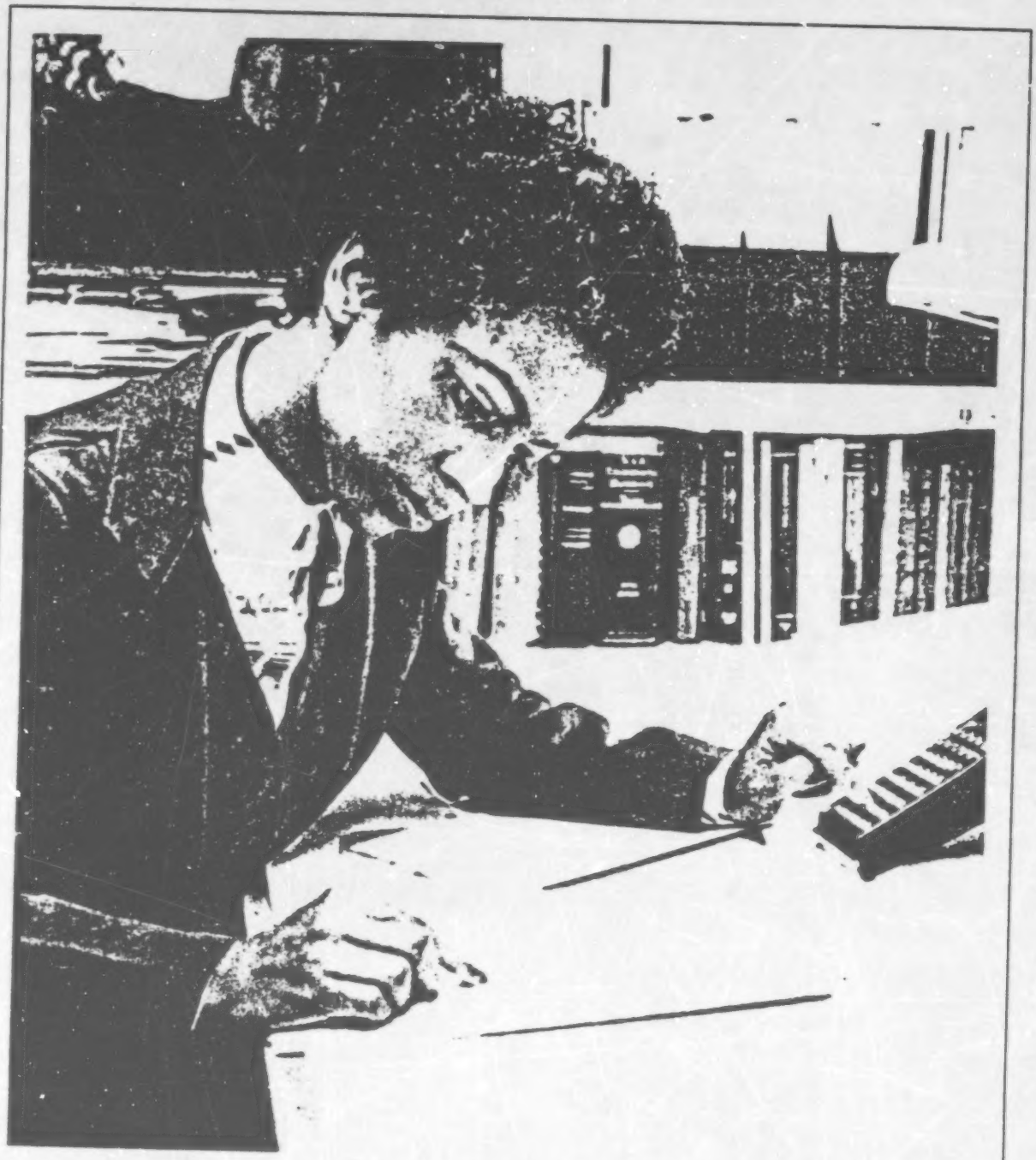
2. You may allow the groups to select their own topics, assign a different topic to each group, or assign the same problem area to two or more groups and have a competition to see which group can come up with the largest number of valid responses. Some possible topics include

    a. pollution
    b. space travel
    c. the energy crisis
    d. food supplies
    e. mass transit

3. This activity can be completed in a single brainstorming session, or students can be asked to do further research on the problem, possibly presenting their findings in a panel discussion where they role play the scientists who might be involved in solving the problem.

Scientific and Technical Occupations

Electrical Engineer



As vice-president in charge of engineering, Gloria Blue uses her talents to develop new hi-fi products.

Excerpted from Exploring Careers, U.S. Department of Labor, 1979.

Exploring Careers

Gloria Blue pulled into her parking space and turned off the engine. Climbing out of the car, she noticed how warm the morning was. Although she had moved to Los Angeles from Chicago over 6 years ago and should have been used to the weather by now, spring-like days in November still seemed odd.

Gloria entered the modern brick building with the sign above the double glass doors that read "Auto Fidelity Inc." After greeting the receptionist, she stopped to chat with another co-worker before climbing the stairs to her own office, the one marked "Vice-President of Engineering."

Laying her briefcase on the table, Gloria ran over the day's work in her mind. Normally Friday was the easiest workday, but there'd be plenty to do today before going home for the weekend.

Auto Fidelity Inc., known as AFI, is one of the nation's leading distributors of sound equipment for cars and other vehicles. AFI manufactures radios, tape players, speakers, and other products and distributes them to stores and dealers across the country. As Vice-President of Engineering, Gloria Blue uses her electrical engineering skills to develop new products that meet the needs of customers. She is the bridge between the technical side and the sales side of AFI's business.

Armed with a cup of coffee, she sat down to the first task of the day—completing a technical bulletin she had begun earlier in the week. Since many car owners install two pairs of speakers in their cars instead of just one, Gloria and her staff had designed a new connector plug that allows the customer to connect all four speakers to the radio without splicing wires. But AFI couldn't get its sales campaign underway until the sales staff understood what the new connector could do, and what advantages it offered. Gloria's bulletin would explain all this to the sales people.

She had nearly finished writing it when Bob Cohen, chief design engineer, called. "Come on down to the lab when you have a chance," he said. "I've finished the model of the equalizer."

"I'll be right down," answered Gloria, anxious to see Bob's results.

Bob was leaning over a table, changing a few details on a drawing, when Gloria walked into the room. "It's over here," said Bob, turning to one of the metal workbenches littered with electronic devices, handtools, wires, half-dismantled radios, and loose parts. He picked up a small metal box with several knobs on one side and handed it to his boss. Removing the top and examining the box closely, Gloria commented, "I think we have a winner."

The equalizer was one of her better ideas. She had followed trends in the home stereo equipment market as well as in the automobile products sold by AFI's competitors. From all she had seen, Gloria felt that the public would buy a combination power booster and equalizer. The booster would increase the loudness of a radio or tape player, while the equalizer would allow the listener to adjust the volume of the treble, middle, and bass tones individually, thus "equalizing" the sound. No other company offered such a product for automobiles.

After creating the general concept, Gloria had handed the idea to Bob and his staff, who actually designed the device. They figured out what parts to use, arranged them in a package, and tested it. But they worked under the guidance of Gloria, whose job it was to make sure the product would be attractive, reliable, and inexpensive.

Gloria and Bob, both electrical engineers, performed quite different engineering jobs at AFI. Bob's position was purely technical, while Gloria had moved into a management job. The work was a far cry from what she had dreamed about as a teenager.

When she was in junior high, Gloria was sure she'd be a nurse one day. Her favorite aunt was a head nurse at one of Chicago's largest hospitals, and Gloria enjoyed talking with her about the job. By her senior year in high school, she had changed her mind. A long talk with her guidance counselor encouraged her to think about a career that involved mathematics; Gloria always had made excellent grades in math. So she started college with plans to become a math teacher.

That fall she met her husband-to-be, Larry, who was a junior at the engineering school. They frequently studied together and discussed their courses. Gloria grew more and more interested in Larry's engineering problems, and liked trying her hand at solving them. Before the school year was over, Gloria had decided to switch to electrical engineering. It took all summer to sell her parents on the idea but they finally agreed that the decision was hers to make. Gloria recalls how proud they were when she received her bachelor's degree in engineering.

Gloria started out in the research and development division of a large manufacturer of electrical products in Chicago, and spent the next 10 years there. She developed a solid reputation in the area of product development. At the same time, she was attending evening classes in business and management to earn a master's degree in business administration. This combination of technical and nontechnical skills made her just the right person for the California job advertised by AFI.

Gloria and Bob discussed the equalizer for almost an hour. Once the company's designer developed the cosmetics, or outer appearance, for the product, the factory could begin producing it. Then, after testing, it would

appear in the stores. Gloria looked forward to that day: of all the things she did for AFI, she most enjoyed seeing an idea grow into a successful product.

On her way back to her office, she bumped into Jim Leviton, the company president. "By the way, Jim," said Gloria, "I've looked at that new spectrum analyzer that California Instruments makes and read the literature on it. It can test a radio in about 2 seconds, much faster and better than we can now. And even though it costs $6,000, we need it badly for our laboratory."

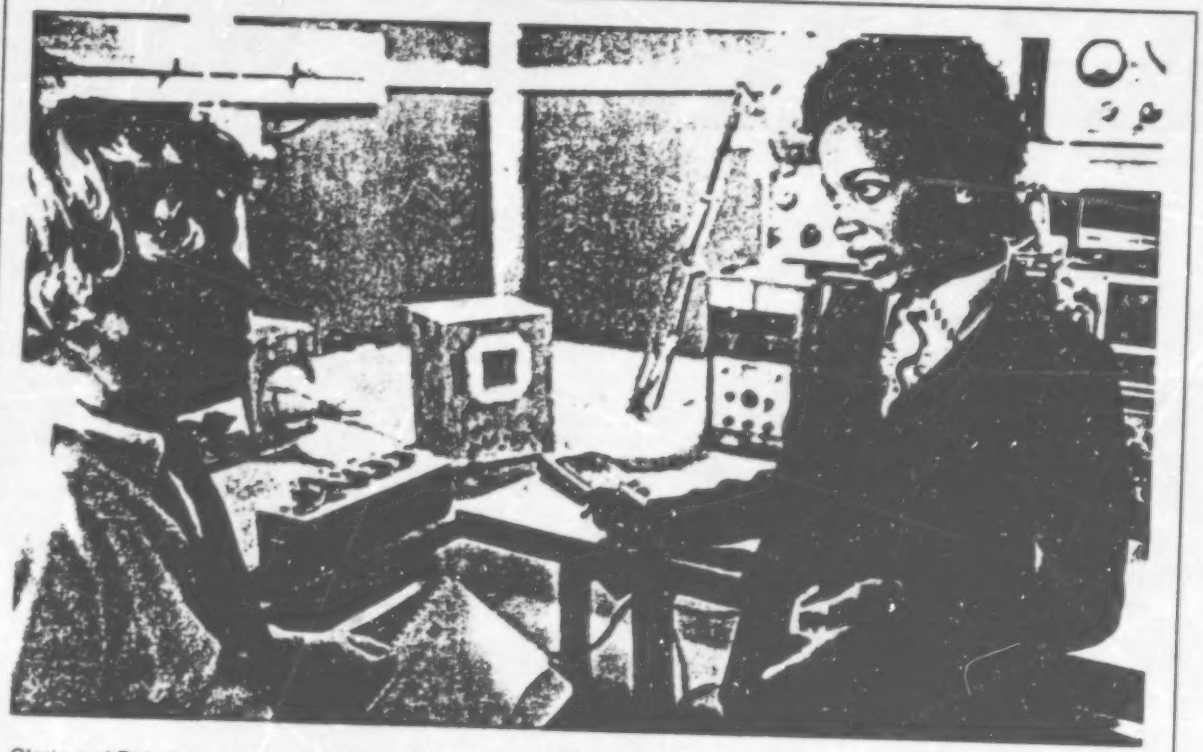
"Let's get together with Al and decide if we can afford it," answered Jim. "How about this afternoon?"

"Fine," replied Gloria, "as long as we don't talk too long. I'll have that sales bulletin on the connector done before lunch, but I still have some preparing to do for Monday's meeting with Toshiro."

"That meeting will be a long one," thought Gloria. Hero Toshiro is an engineer who works with the manufacturing division of AFI. Gloria gives him her ideas in the form of a drawing or, as with the equalizer, a model. He and his staff then complete the design and put it into production. Gloria was encouraging the development of thinner and thinner radio and cassette mechanisms for the new year. She felt that the latest trends were leading in that direction, and she hoped that Toshiro and his staff could develop them in time for the new product year. At their Monday meeting they would discuss problems and progress of the new design.

After the conversation with Jim, Gloria continued on her way back to her office. "You'd never know how much work I have by looking at my desk," she thought as she sat down. The desk top was large but fairly empty. Between the "In" box on one side and a stack of trade journals on the other lay the bulletin she was working on. Everything else was put away. Gloria felt that you couldn't get ahead unless you were organized. And she was proud of her talent for organization.

Gloria glanced at her watch. It was 11:30, and she had an appointment for lunch at noon. With quick strokes of her pen she continued writing, changing a word here and adding a sentence there, until the bulletin was finished. Then, after checking the diagrams once more, she gave it to her secretary to be typed.



Gloria and Bob discuss plans for a new product. "A career in engineering has given me the opportunity to express myself creatively," says Gloria.

LIST OF SELECTED SCIENCE AND ENGINEERING OCCUPATIONS

A. Life Sciences

- Agronomy
- Anatomy
- Animal Husbandry Specialist
- Biochemist
- Botanist
- Cell Biologist (or Cytologist)
- Ecologist
- Embryologist
- Forester
- Geneticist
- Marine Biologist
- Microbiologist (or Bacteriologist)
- Neurobiologist
- Physiologist
- Range Manager
- Pathologist
- Pharmacologist
- Zoologist (may be entomologist, icthyologist, mammalogist, ornithologist, etc.)

B. Physical and Earth Sciences

- Astronomer
- Chemist
- Geologist
- Meteorologist
- Oceanographer
- Physicist

C. Mathematics and Related Sciences

- Computer Programmer
- Mathematician
- Statistician
- Systems Analyst

D. Engineering

- Aerospace Engineer
- Agricultural Engineer
- Biomedical Engineer
- Ceramic Engineer
- Chemical Engineer
- Civil Engineer
- Electrical Engineer
- Industrial Engineer
- Mechanical Engineer
- Metallurgical Engineer
- Mining Engineer
- Petroleum Engineer

ACTIVITY 11

EMPLOYMENT OUTLOOK FOR SCIENTISTS AND ENGINEERS

I. Background Information for Teachers

Although projections about future employment opportunities are never totally accurate, there is information available that can be useful to students as they consider various career options. At the present time the employment outlook for people in technical fields is much better than for those with liberal arts training. For example, the College Placement Council recently predicted that there would be a 17 percent increase in the hiring of college graduates with degrees in science and mathematics and a 26 percent increase for those with engineering degrees but an 8 percent decrease for those in non-technical fields compared to the previous year.

Among the professional fields with an unfavorable employment outlook are political science, psychology, sociology, and elementary and secondary school teaching. Not surprisingly, the fields with the greatest demand for additional workers such as engineering and computer science typically pay the highest salaries, while those with an oversupply of qualified people such as the social sciences generally pay less. In addition, fields that require mathematics and technical skills usually pay more than those which do not. Section 5 of the RESOURCE MATERIALS FOR TEACHERS includes additional information on employment outlook and starting salaries for people in both science and non-science fields.

The purpose of this activity is to give students one tool for learning about employment opportunities by teaching them how to read classified advertisements. Optional parts of this activity involve students in learning about the employment outlook in their local area as well as salaries offered in various fields.

II. Guidelines for Teachers

A. Distribute the worksheet "Learning How to Read Help-Wanted Ads" and have students complete the bottom section. Point out that the ads do not always contain all of the information requested on the chart so they will have some blank spaces.

B. Have each student select one or two science ads from the local newspaper or that of a nearby city and write down the information called for in the worksheet (specific science field, employer, educational experience required, and salary). You may need to point out that some jobs with engineer in the title are not really engineering jobs, e.g., custodial engineer.

WORKSHEET

"Learning How to Read Help-Wanted Ads"

(1) ENGINEERS

Coal company has immediate openings for engineers for our mining operations throughout the mid-west. Qualified candidates for these positions will have a B.S. in Civil, Industrial, Mining or Mechanical Engineering. Some positions require travel. Starting salaries from $23-26K.

(2) PROGRAMMERS

Major bank needs programmers. Bachelor's degree in computer science with emphasis on business or at least one year of experience in applications programming. Salary commensurate with qualifications and experience.

(3) POST-GRADUATE RESEARCH BIOLOGIST

Ph.D in biology or biochemistry; 1 year postdoctorate to do research in animal metabolism; salary $24,500-$29,400 depending on qualifications.

(4) CIVIL ENGINEER

County government needs project engineer for storm drainage projects; review water and sewer plans. Position requires a bachelor's degree in civil engineering and two years of engineering experience.

Ad	Science Field(s)	Employer	Level of Education and/or Experience Required	Salary
1				
2				
3				
4				

C. OPTIONAL: Obtain copies of the "Help Wanted" section of your city's Sunday newspaper and/or that of a nearby large city.

1. Have each student read the ads and write down answers to some or all of the following questions:

   a. What companies in the local area are seeking scientists and engineers?

   b. How many jobs are advertised in each of the major science fields: (a) Engineering, (b) Physical and Earth Sciences, (c) Biological Sciences, (d) Mathematics and Computer Science?

   c. How many jobs are offered for people with degrees in non-science jobs such as social work, psychology, English, etc.?

   d. How do the salaries offered by the science jobs compare to those offered by professional non-science jobs? by non-professional jobs such as clerical workers?

2. Have the students discuss what they learned about employment opportunities, e.g., What fields seem to have the most job openings? the highest salaries? Point out that in the nation as a whole the employment outlook for people in science and engineering fields is better than for those with liberal arts training, and that at present computer science and engineering tend to offer the largest numbers of jobs and the highest salaries.

D. OPTIONAL: Have students use information about average starting salary offers to inexperienced bachelor's degree candidates (see Section 5 of the RESOURCE MATERIALS FOR TEACHERS) as a basis for mathematics problems. For example, you could provide monthly figures and have the students calculate hourly salaries. Hourly wages are particularly meaningful to youngsters since they can use babysitting, mowing lawns, etc., as comparisons.

ACTIVITY 12

PLANNING FOR A CAREER

I. Background Information for Teachers

The purpose of this activity is to make students aware that they should begin thinking about the careers they might like to pursue and how to prepare themselves for these careers. The Annotated Bibliography included in Section 6 of the RESOURCE MATERIALS FOR TEACHERS lists a number of sources of information about careers in section F. Note that the first few entries contain information on many careers while later entries are specific to science careers and are organized by major field.

II. Guidelines for Teachers

A. By now some of your students may be considering careers in science-related fields while others will have decided that science is not for them. Make the point that whether or not the career they eventually decide to pursue is in science, there are certain steps that all of them should follow. Make a transparency of page 12.4 and use it to present an overview of these steps one at a time starting from the bottom. (Use a sheet of paper to cover up the steps you have not yet discussed.) You may expand on the various points as you see fit, drawing from the information below or from other sources.

1. The Decision Is Up To YOU!

It is important that adults who have influence on your life--your parents and relatives, teachers, counselors, friends--help you think about possible careers for your future. But, in the end it is you who will decide what you want to be. You should take the initiative in thinking about yourself and the types of jobs you might like to do. Think about yourself in different careers and try to picture whether you might enjoy them and be good at them. Then do some planning to be sure you are preparing for careers you might like. You might change your mind over the years, but it is important that you think about the possibilities instead of ignoring them and finding out after you have finished school that you are not prepared for any careers you really like.

Some of the steps below will help you think about careers and how to prepare for them.

2. What Do You Enjoy and Do Well?

You should stop now and then and think about your interests and abilities. Ask yourself questions such as the following:

- Does it matter a lot to me if I work indoors or outdoors most of the time?

- Do I like to work alone or with others? Some of each?
- Am I creative, or would I rather carry out procedures others have devised?
- What subjects do I like to study in school?
- What hobbies and interests do I have?

Teachers and counselors may talk with you about your test scores in mathematics, reading, writing, science and other areas. And as you get older, they may talk to you about results of tests that explore your interests. All of these may help you think about possible careers.

3. What Career Opportunities Are Available?

We have learned about some careers in science and engineering. Books such as Exploring Careers and the Occupational Outlook Handbook describe many other careers, both science-related and non-science related. As you read these you will learn about the kind of work done, the salaries offered, and the likely availability of job openings in the future. The school and public libraries may have additional information on some of these careers. You can also write to some of the professional societies listed in the Occupational Outlook Handbook for free materials about particular careers. In addition, most companies have brochures that describe career opportunities, and many would be willing to give you a tour or have you interview their employees.

4. Hobbies, Clubs, Summer Jobs

Sometimes you can determine that you are really interested in a career--or really not interested--by spending time working in that area. Volunteer work or summer employment may not be realistic for you now, but by the time you enter high school they will be.

5. Education and Training Requirements?

Once you have selected one or more careers you might be interested in, you should find out more about these fields. In addition to the sources of information we have already mentioned, you can talk to the school counselor about these careers and the preparation you will need. College and technical school catalogues can also help you determine what courses you will need to enter a particular field.

6. Keep Your Options Open!

While you may already have a pretty good idea of your present interests and abilities, you may not know enough about different careers to decide now whether you want to be in a science-related career. Even if you are pretty sure you want this type of career, you probably have not made up your mind between science and engineering, let alone among specific careers such as a biologist, mathematician, civil engineer, or electrical engineer.

7. Work Toward Your Goals!

In most cases you can be anything you set your mind to being. Don't let other people talk you out of a possible career you really want because they think it is inappropriate. Start thinking about what you want to do, find out how to prepare for it, and go from there.

7. Work toward your goals!

6. Keep your options open!

5. Education and Training Requirements?

4. Hobbies, Clubs, Summer Jobs

3. What career opportunities are available?

2. What do you enjoy and do well?

1. The decision is up to YOU!

PLAN FOR YOUR CAREER!

12.4